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PRODUCT ENGINEERING

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McGRAW-HILL PUBLISHING COMPANY, INC.
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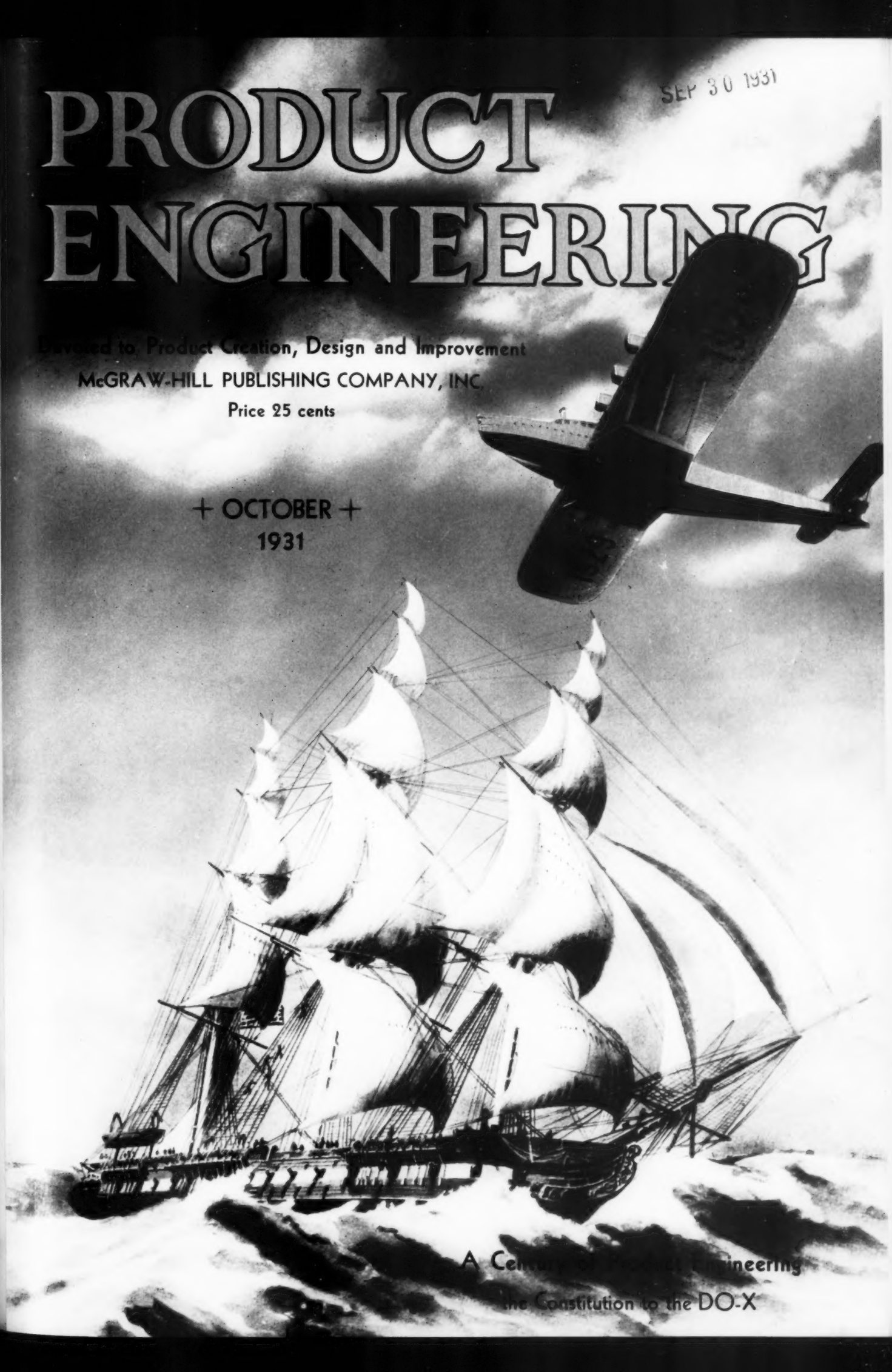

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THE JOHNSON FRICTION CLUTCH

AS USED ON

RUBBER WORKING MACHINES

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A No. 2 Double JOHNSON Clutch between Spur Gear is installed in the gear box, and is used to raise and lower the table which slides up and down on gibs.

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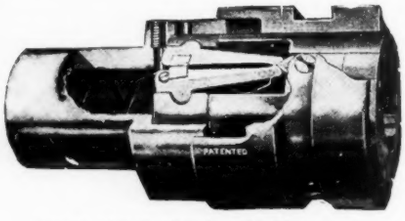
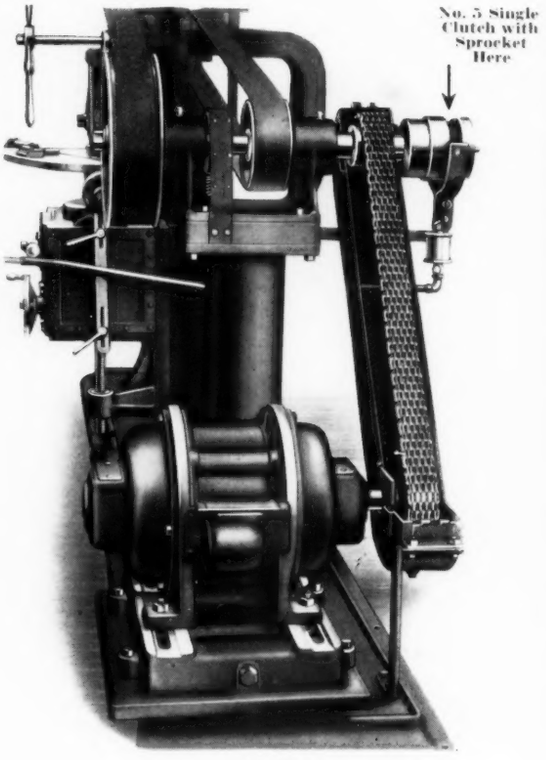


Single Clutch Showing Working Parts

JOHNSON Clutches operate Rubber Working Machines satisfactorily. The sensitive instantaneous response of JOHNSONS make them a wide choice for use on a variety of Rubber Working Machines such as the two illustrated, on Tire Wrapping Machines, on Machines for Polishing Rubber Bag Moulds for Making Tires, on Tire Building Machines, etc.—INVESTIGATE.



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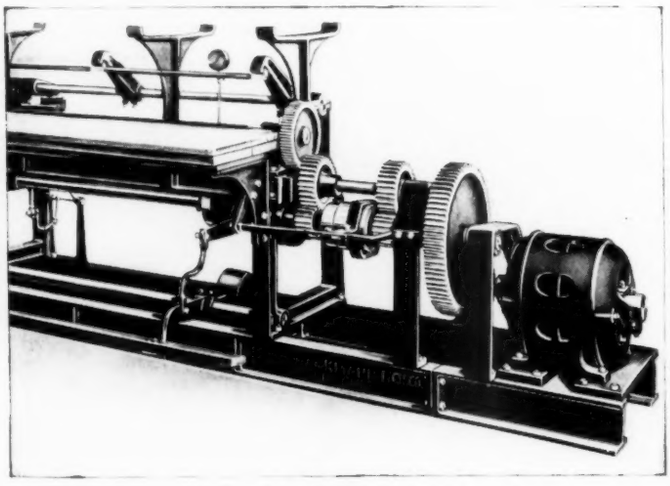
Rubber Cleaning Machine

A No. 8 single JOHNSON Clutch with Spur Gear on the hub is used on the main drive of this Rubber Hose Wrapping Machine.



Rubber Hose Wrapping Machine

Single Clutch with Spur Gear

On drives where high speed, starting heavy loads, excessive slipping or continuous engagement is required of the clutch use the New SUPER-JOHNSON which has a special heat resisting material on the O.D. of the expansion friction ring.

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THE CARLYLE JOHNSON MACHINE CO. MANCHESTER, CONN.

PRODUCT ENGINEERING

Devoted to the Interests of Engineers and Executives Responsible for Product Creation, Design and Improvement

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"Industry exists basically to serve the needs of the people and therefore production and consumption must be coördinated"

—*said* GERARD SWOPE
President of General Electric Co.

— And there is a very important part that the product engineer can play in this coördination.

HE CAN create a new product to fit a need, and production in his plant will get under way. He can check on trends in sales to prepare ahead for any slackening in demand. He can keep a watch for start of competition and devise engineering ways to meet it. He can help create new needs in the market his product serves. He can warn of the need to limit production and eliminate the need through product improvement. He can determine the saturation point for sales and provide means to raise the point or to go around it.

It is a known fact that he can do these things because in every division of industry today there are busy plants due to the fact that product engineers in these plants are doing all these things.

There was a day when the successful product engineer sat at his desk in his department and others came to him to tell him what they wanted. The present day finds him in the sales department, and the plant, and out in the field that his product serves. He is a primary factor in coördination between production and consumption.

PRODUCT ENGINEERING

PRODUCT ENGINEERING

McGraw-Hill Publishing Company, Inc. OCTOBER, 1931 Volume Two, Number Ten

In Behalf of a Standard Non-ferrous Classification

By GEORGE S. BRADY
Managing Editor, Product Engineering

Product engineers must have a comprehensive grasp of the properties of the usual mill mixtures of non-ferrous alloys. They need also know to a reasonable extent what can be expected from the less usual ones. But the multitudinous mixtures with many meaningless names that are being advanced are most confusing to the engineer. There is no comprehensive classification. Infinite are the possible mixtures, each varying to some extent in physical characteristics. But probably 75 per cent of all wrought brass produced by the mills is one mixture. Naturally, special requirements need the counsel of the specialist, but probably less than 5 per cent of the special uses really requires a special mixture. Why not have classification and standardization? Discussion is invited

WITH the ever-increasing number of non-ferrous alloys being employed in engineering construction, a comprehensive general method of group classification is becoming of paramount importance. There has appeared to be, at times, a great amount of mystery thrown about certain trade-named alloys, which when once dissipated from the minds of specifying engineers has the opposite effect from that evidently intended by the producers. This, however, does not mean that the use of trade names is a bad thing. On the contrary it means that trade names can very well be continued, but, except for patented compositions, only as designations of quality, technique and uniformity. Where a trade name is implied to mean that an alloy is a mysterious material with super-physical characteristics there is bound to be set up in the mind of the prospective purchaser a feeling that he can produce a material just as good himself. Actually, there are many small foundries attached as departments to manufacturing plants that might be better closed up, and would be if the engineers responsible for the product realized that the specialized foundry can almost invariably give them better and more uniform castings, often at less expense. Why, then, shouldn't the legitimate producers be anxious to agree upon some standard classification that would make it easy for the engineer to get a comprehensive mental picture of the essential differences in non-ferrous alloys?

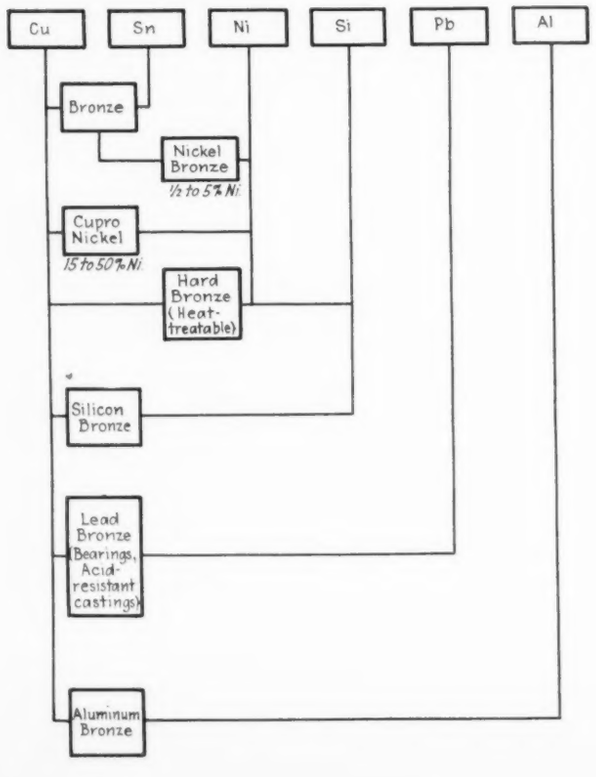
In discussions of non-ferrous metals, probably too much importance has been attached by engineers to the chemical or metallurgical content of the alloys, in spite of the fact that metallurgists are continually bringing out that technique in mixing, melting, pouring, cooling and heat-treatment is of vital importance. Where formulas have been given merely to designate the class of alloy and to indicate

a range of physical qualities, it has been found that engineers have specified the percentages to their own foundries, where, without any knowledge of the particular technique involved, inferior castings have been produced and the formulas consequently condemned.

Every consideration from the user's standpoint indicates that there should be a general system of classification of non-ferrous alloys that would be of service in placing the engineer, foundryman, mechanic, and purchasing agent on a common ground for comparisons of expected characteristics in alloys. In the development of such a system there is need for standardization on a few alloys in each classification to avoid the infinite multiplying process now going on. There are brass foundries today producing as high as 150 different alloys, which number could be reduced easily to almost 50 by careful selection of representative alloys in each class. In wrought alloys the brass mills are producing hundreds of different alloys of which a relatively small number constitute the major sales and the special mixtures are only a small part of the output.

Producers of trade-named alloys should feature their trade names as marks of technique and quality rather than as symbols of definite mixtures. This is already being realized and done by some. It should be realized that prospective purchasers can have a definite metallurgical analysis made of any such mixture for a few dollars, but technique can only be obtained at a large cost in both time and money. There should be no hesitance, therefore, in locating a trade-named alloy within a standard classification.

The "Bronze" Group of Alloys



There are now in use certain alloy class names of such current acceptance by the outside public as well as by engineers that their use should be continued. Examples are brass and bronze. But general classifications of this kind are of such broad meaning that little specific is indicated to the engineering mind. They should be broken down if they are to be used intelligently in engineering specifications.

As an example of the confusion that reigns in the classification of non-ferrous alloys we need only examine this great group of brasses and the bronze group. In the first place, outside of the brass industry itself engineers often confuse the two terms, although brass is very definitely a copper-zinc mixture and bronze a copper-tin. In some plants the difference between brass and bronze is more a matter of color, while in others the term bronze indicates something *cast* from brass, bronze, or composite metals.

Some Common Commercial Names of Copper Alloys

BRASSES	BRONZES
High brass	Spring bronze
Low brass	Statuary bronze
Rich-low brass	Bell metal
Gilding metal	Car brass
Cartridge brass	Anti-acid bronze
Muntz metal	Bearing bronze
Admiralty metal	Phosphor-bronze
Forging brass	Steam bronze
Bristol brass	High-lead bronze
Clock brass	Gun metal
Leaded high brass	Plastic bronze
Naval brass	Semi-plastic bronze
Nickel brass	Hard bronze
Oreide bronze	Hydraulic bronze
Spring brass	Manganese bronze
Casting brass	Silicon bronze
Red brass	Aluminum bronze
Yellow brass	Copper-lead
High-strength brass	Nickel bronze
Electrical brass	Ounce metal

Probably three-quarters of all the commercial sheet brass contains about 65 per cent copper and 35 zinc, known as "common high brass," but there are other regularly-made mixtures put out by the mills under such names as low brass, cartridge brass, rich low brass and gilding metal. There are also hundreds of special mixtures. Cast brasses and bronzes are being marketed under general names, such as car brass, bearing bronze, anti-acid bronze, and numerous "metals." The term "bearing bronze" usually designates a lead-bronze in which most of the tin is replaced by

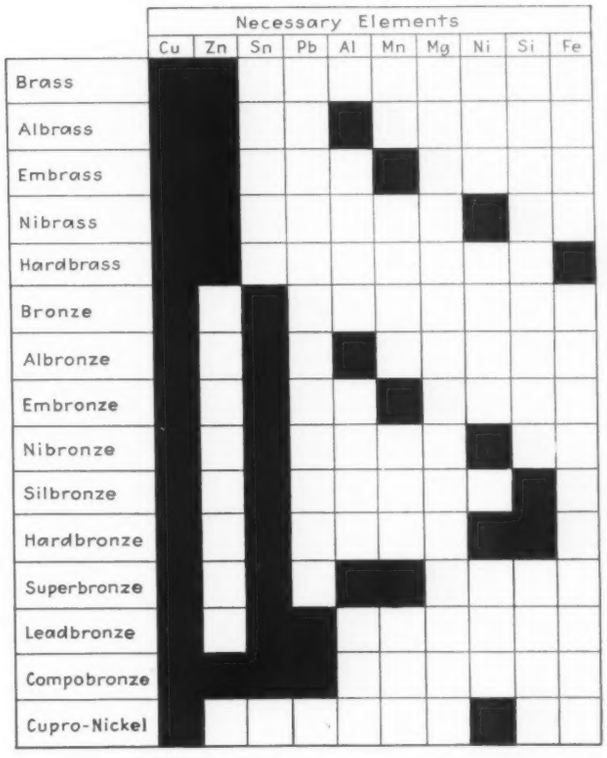
lead, and "car brass" is likely to be a bearing bronze and not a real brass at all.

When it comes to the naming of brasses and bronzes alloyed with nickel and other metals the "mystery" deepens, and the confusing names multiply rapidly. There are about twenty common names in the trade for nickel brass, although the differences between these so-called different alloys are minor. Metallurgically there are well-known reactions that occur when small amounts of certain elements are introduced into brasses and bronzes, but because there are no definite standards great mystery has sometimes been placed about alloys of this nature, and they have been heralded as "high-strength bronze," "hardened copper," "heat-treated bronze," etc.

It is well known to metallurgists that small amounts of nickel and silicon in bronze will form a nickel silicide that hardens the alloy and makes it susceptible to heat-treatment. Something of the same nature occurs when small amounts of aluminum and magnesium together are present. It is known also that tin leaves hard chemical crystals in a copper alloy while zinc does not, so that a bronze will be naturally harder than a brass. It is also known that lead will make a so-called "self-lubricating" bronze, but the shortcomings of such a bronze in lower strength and difficulty of casting evenly is not always told. Where an engineer calls for a leaded brass for ease in machining he must appreciate the fact that the strength of the alloy will be less than it would have been without the lead. It is known that aluminum will harden and increase the tensile strength of bronze, but it has to be realized also by those engineers who specify alloys that one characteristic is always gained at the expense of some other characteristic, and that there are no cure-alls in the metal industry. Without both sides of each problem it is not possible for the engineer to judge the correct alloy for his particular use. His choice for a given use must rest on a balance between strength, weight, hardness, color, structure, frictional qualities, machinability, susceptibility to finish, unit cost, and other factors.

When the S.A.E. began to standardize on steels the situation was just as hopeless as it is at present in the non-ferrous industries. Innumerable differences in characteristics are obtainable in steels by small changes in the amounts of alloying elements, but it was found possible to standardize on groups with average properties and eliminate the indiscriminate ordering to individual specifications. This plan met with opposition at first, but the final result has been that steel mills

Suggested Major Grouping of Copper Alloys



are now able to work to these standard specifications as regular products and turn out more uniform quality much more cheaply. Why is it still necessary for the users of brass, bronze, and aluminum alloys to specify such slight differences in their alloys as to lead to continual confusion and indefiniteness? There is no such indefiniteness today in regard to steels, although the possibilities are just as great.

In the brass industry the following designations of classes of brass have been well established by use over a period of many years:

Brass:
- Muntz metal (60 cu-40 zn)
- High brass (65-35)
- Cartridge brass (70-30)
- Low brass (80-20)
- Rich low brass (85-15)
- Commercial bronze (90-10)
- Gilding metal (95-5)

Some of these are also made regularly with small amounts of lead, and are designated as "leaded high brass," and so on. Moreover, these brasses are made in various degrees of softness and hardness, depending upon the annealing or upon the amount of cold rolling. At the present time other names are being employed by users to designate the same groups of alloys. Thus, the term "commercial brass" employed by the Federal Specifications Board referred in one grade to the mill designation of "high brass," in another grade

to "leaded high brass," and in still another to "Muntz metal." These same grades are referred to in the standards of one of the largest automobile manufacturers as "commercial brass" and "commercial yellow brass." Other users have in many cases varied the compositions slightly and given them numbers or names that are not standard in the trade and are sometimes confused with the numbers and names used by other companies for entirely different alloys.

Suppose it to be assumed that the above mentioned mill designations were to be retained in any general standardization, would it not be easy to have enough standard grades under each group to meet all ordinary requirements? Assuming this for "High brass" we might have: High brass A, High brass B, High brass C, etc. The hardness designation could then easily be added to make High brass AH, High brass A2H, etc. This would serve also to standardize the softness and hardness designations which at present vary among different companies.

Mill Hardness Designations	Designations of One Large User	
Dead soft	000	Soft Drawing Anneal
Soft	00	Drawing Anneal
Light anneal	0	Light Anneal
¼ Hard	1	Quarter Hard
½ Hard	2	Half Hard
¾ Hard		
Hard	4	Hard
Extra Hard	6	Extra Hard
Spring Hard	8	Spring
Extra Spring Hard		

In alloy brasses, a general group name should be agreed upon for each common commercial group, and standard specifications made up for sufficient grades in each group to meet the requirements of the average product manufacturer. This would permit the mills to stock standard grades, and would permit the foundries to eliminate the multitudinous mixtures now being called for by engineers.

If aluminum or another metal is present in a predominating proportion so as to influence the physical characteristics of the brass, the alloy should be given a group name accordingly, such as Albrass, or Embrass (or A Brass, B Brass, etc.). It should not be carried under such a designation as "high-strength brass," which with one company may mean an aluminum brass and with another a manganese brass.

In the bronzes, it is necessary to agree upon a definition that recognizes bronze as distinct from brass. In general, a bronze contains tin instead of zinc, but the copper alloys containing large amounts of aluminum with little or no tin or zinc are also called bronzes, and the copper-lead metals for machine bearings are known as bronzes. This grouping would not be objectional if it were universal. There is no apparent objection to the continuance of the name "superbronze" if it is agreed by all to indicate a copper alloy containing both aluminum and manganese, as it is now recognized by some important users. In regard to the copper-nickel alloys, the Federal Trade Commission has ruled against the use of the names "German silver" and "nickel silver," but no satisfactory names have as yet been substituted.

The A.S.T.M. has already established standards for ingot metals for casting which would be a decided help to foundries. But these standards are designated by serial numbers, and large producers of ingot metals retain their own numbers. It is common practice for them to say "Our alloy No. X corresponds approximately to A.S.T.M. alloy No. Y." Engineers, themselves, can correct this condition by specifying to accepted standards.

Why should there not be a general acceptance of class names for each group of alloys and then a standard system to give some designation of the content or grade of the alloy? The accompanying table gives some proposed group names for copper alloys. Aluminum and white-metal alloys might likewise be classified. The indefinite terms such as "casting brass" could well be abandoned. It has been proposed that the percentages of the constituents be named with the general name of the alloy. "60-40 brass" or a "90-10 bronze" will give a definite impression to the mind of the engineer as to the physical properties, and if the elements are kept always in order, the specification of an "85-5-5-5 composition bronze" will have a definite reaction. But unquestionably some more simple manner of number designation could be found by an ingenious committee formed for the purpose of inquiring into the subject. At least grades designated by symbols as above could be decided upon under each group, and the major percentage of the ordinary engineering requirement then be handled by standard classifications. The problem is not at all hopeless, and something must be done towards better standardization of commercial alloys from the user's standpoint. This standardization should make possible a reasonable number of commercial alloys in each of the great groups, including the alloys of aluminum, the copper-nickel alloys, and the lead and tin white alloys, as well as the brasses and bronzes.

Two vibrating screen cloths added to this bucket loader make it a portable, one-man screening plant capable of producing three classifications of product. The counterbalanced screen frames are driven at the center by an eccentric shaft belted to a power take-off on the engine

Trends in Product Engineering

Aircraft development outstanding — Bendix brings out notable clutch control —Diesel engines going forward — Higher speed looked for in rock drills— Electrical research is developing many saleable items—Factory-made metal houses visualized.

AIRCRAFT development news holds an outstanding position this month. Ludington has installed 68-min. service between New York and Washington, using low-wing Lockheed Orions flying at 2 miles a minute, and marking the trend towards still higher commercial speeds. The flight of the DO-X is claimed to herald an era of very large freight-carrying heavier-than-air craft. The Cleveland Air races multiplied discussion on comparative worth of airplane and autogyro designs; and from Germany comes news of a "flying wing" with no tail and consequent reduction in dead weight, capable of making sharper turns than an autogyro. It attained 90 m.p.h. with a 30-hp. pusher-type engine, and is controlled by independent vertical rudders at the wing tips. That the "flying wing" idea is sound is proved by the success of the extremely close-coupled Gee Bee that took the Thompson Trophy at Cleveland and had all the lateral stability of its longer-tailed competitors. Meanwhile the Government has purchased a "windmill plane" for test purposes, and there is a definite indication that takeoff and landing ability in small areas will be an important future design element.

The argument over tractor type and pusher type propellers seems due to grow in volume and intensity. Stout's Sky Car uses a pusher and the DO-X has both types. Various types of cooling are also coming in for development. The DO-X, originally powered with 12 air-cooled engines, found Curtiss water-cooled engines better for its purposes. The British 388-mile Schneider Cup racers use all wing surfaces for water radiators and fuselage and tail fin surfaces for oil radiators, carrying

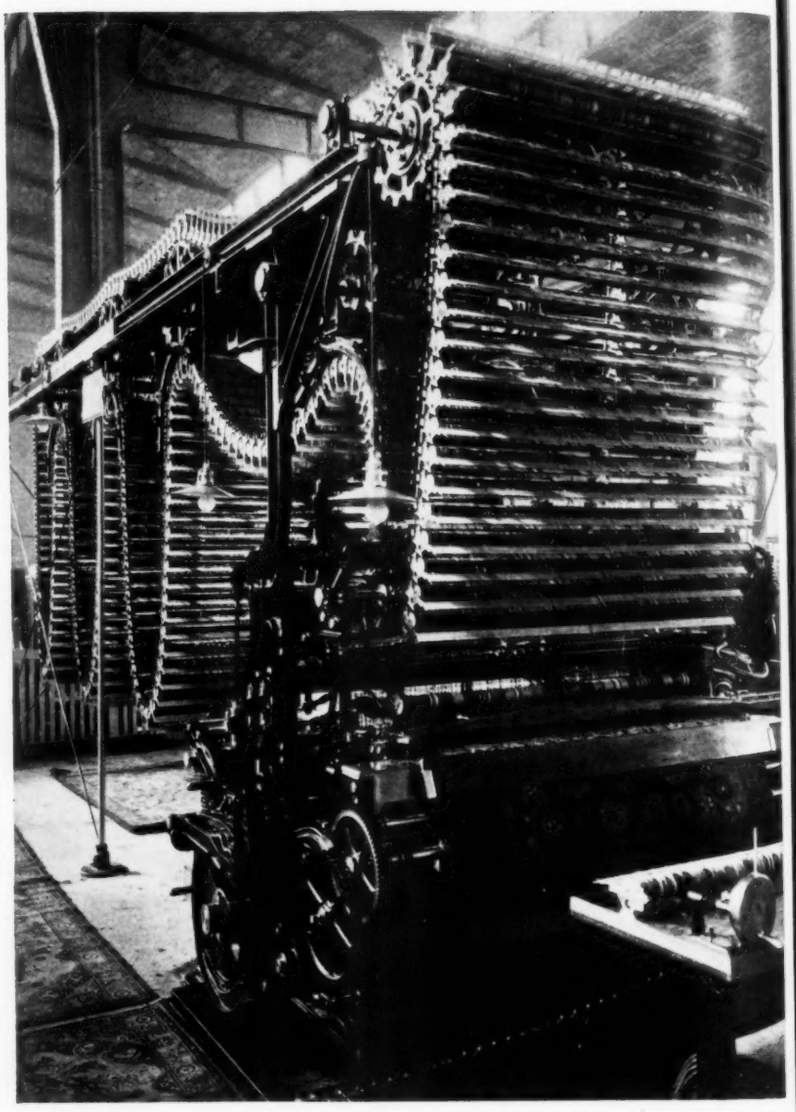
fuel in the floats. These radiators, 40 per cent more efficient than those on the 1929 racers, permit pilots to use the full power of the new Rolls-Royce engines, increased from 1,900 to 2,200 hp. by non-weight-increasing internal changes. Coolers or radiators dissipate 40,000 B.t.u. of heat per minute, equal to about 1,000 hp. in heat loss. If this could be utilized for power, speeds of 500 m.p.h. would look even more close. And German designers have built a single-seater plane for $226. Lightweight alloys are going in, especially magnesium for massive structures and aluminum alloy for strength.

Auburn has shown what new designs are capable of doing during a depression. Auburn launched five new cars last January at a so-called "unpsychological time;" sales were greater in the first eight months of 1931 than in the entire year of 1930. The new Auburns incorporated striking developments in body lines and many advances in details. The story of that company's development methods is given on page 452 of this number. Regarding auto body changes, J. Ledwinka, chief engineer for Edward G. Budd Manufacturing Company, says that the buying public will not accept a radical change overnight, but wants changes made progressively in easy stages. He looks forward to development of full streamlining, reduction in weight, all-steel construction, and better weight distribution on the tires.

Rear mounting of engines is now an accomplished fact and should soon be applied to passenger automobiles, as proposed in *Product Engineering* in Dec., 1930.

Caterpillar, making further price reductions, brings its tractor price down about 35 per cent in six years, made possible by "ever-improving engineering and research facilities, more concentrated and complete manufacturing plants, and bettered production practices." Caterpillar has brought out a Diesel-driven tractor which requires no adjustments in the field and has some new timing features on the fuel injection system. The apparatus is timed, regulated, and adjusted in the factory and a spare set is furnished for use while one is sent for repair. Complete enclosure and dust-proofing is resorted to and an improved pre-combustion system is employed. Acceleration and flexibility are attained by a variable-speed governor control. Engine controls are centralized at one lever at the driver's seat. Fuel consumption is but 0.061 lb. per drawbar hp. The fuel valve is of the single-orifice type and the filter of the two stage type. Starting is effected by a gasoline motor with a Bendix drive to engine. Bendix, incidentally, is bringing out a vacuum clutch control attachable to cars already in service and providing another form of free-wheeling device. It operates on the same principle as the B-K vacuum brake booster. With the valve in the line between intake manifold and operating cylinder mechanically interlocked with the accelerator movement, the clutch is disengaged as soon as the driver lifts his foot from the accelerator. Gears can be shifted as soon as the engine reaches idling speed, which is almost instantly.

Diesels, by the way, continue their extensive recent development. Hooven, Owens, Rentschler

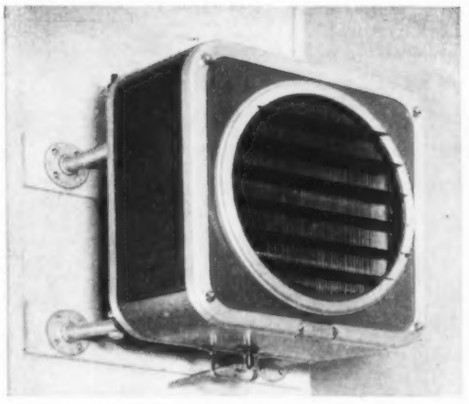


ALMOST human in action, this high-speed automatic British Austin loom weaves rugs up to 54 in. wide

has a $1,500,000 contract for five Diesel-driven electric generating units for the city of Vernon, Calif., rated at 6,000 kw. each, and claimed to be not only the largest Diesel engines constructed in this country, but also prime movers of the largest American Diesel-driven plant. Said to be largest of their kind in the world are two Burmeister & Wayne 10,000-hp., 110-r.p.m. Diesels for powering the 27,000-ton White Star liner "Georgic," now building. These engines have 10 cylinders each, 33-in. bore, 59-in. stroke. Inland Waterways Corporation has just received a Diesel-powered towboat said to be most powerful of its type. It can handle 10,000 tons of freight up the Mississippi at 4 m.p.h. Diesel propulsion has long been considered advantageous for inland waterway service but the difficulty has been to apply Diesels to shallow-draft craft and to gear a Diesel down to the speed of the familiar slow-speed paddle wheel. This design incorporates a tunnel-type propeller. McIntosh & Seymour 1,100-hp. Diesels of the trunk-piston 8-cylinder design are used with lowered height and weight to meet requirements.

Domestic oil-burners likewise using low-priced fuel show an increase of 6,100 per cent in number in this country in the last ten years, the total to be about 774,500 at the end of this year.

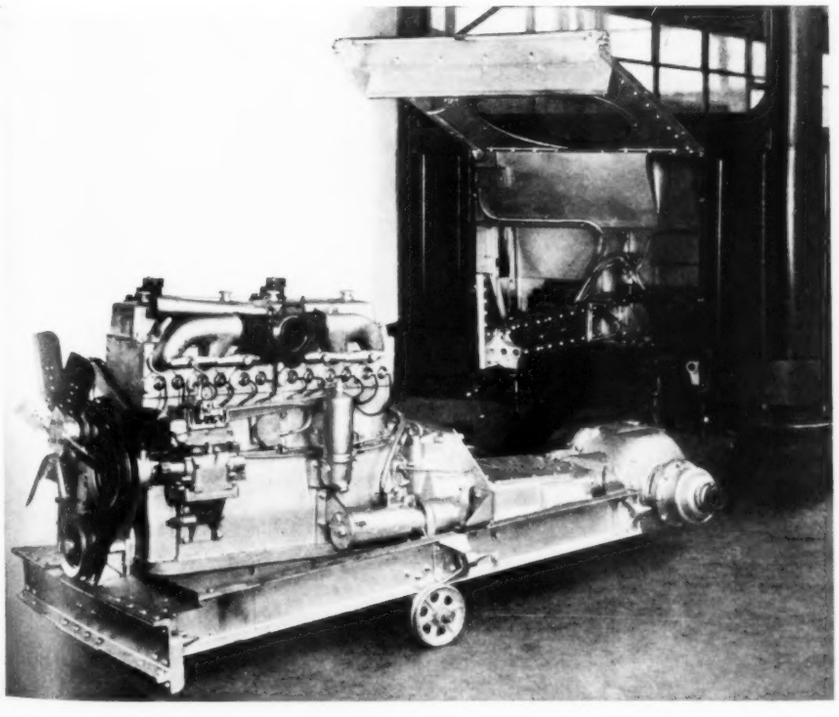
A new stunt in engine valve cooling is the Thompson forged valve with copper core taking up 10 per cent of its diameter. Copper transmits heat 20 times faster than valve steels, and these valves at 3,000 r.p.m. were only dull red as compared with usual valves bright red, indicating the approach of elimination of troublesome water cooling.



Home air-conditioning units open an extensive design field. Most suck air through water-cooled radiators. For railway cars they are operated by ejectors

Among machine tools a forward step is the use of an electrical circuit in a LeBlond automatic lathe for facing and forming, whereby a cam actuates a switch after the rough cut to cut out part of the resistance in the shunt field circuit of the driving motor and thus reduce the spindle speed for the light finishing cut. After this cut is taken, another cam throws out the shunt and the normal spindle speed is resumed. On a drilling and centering machine (Sundstrand), a Westinghouse-Wise transmission (*P.E.* — p. 234, Vol. 2) is optional equipment to provide four spindle speeds. A semi-automatic infeed unit (Cincinnati) permits several diameters of a shaft to be ground simultaneously. A flat-stepped cam controls the relative position of the wheel and the work. Solenoid stops control the travel of the stepped cam to bring the proper step in line with a positive block stop. The cam bar is actuated hydraulically. Two surface grinders (Norton and Mattison) embody wheel spindle drives with the rotor mounted directly on the spindle and the stator placed in a suitable housing. This arrangement eliminates driving trains and delivers more developed power to the wheel.

A projection welding machine has been evolved to the point where it is possible to weld two pieces of ½-in. steel plate, the electrical consumption being



REAR-MOUNTED removable 150-hp. engine and rear axle center unit of new Yellow Coach. Motor units for trolley-bus service may be substituted without body or chassis changes

75 kva. Die-block pressure available is 5,000 lb. The upper die block follows the work as the points soften, by reason of a helical spring in the upper toggle. Cam control of the toggle, welding current switch, and motor switch gives automatic control. GE engineers have designed automatic atomic-hydrogen welding equipment.

Convenient column design in one lapping machine (Moline) is effected by welding a long strip of steel plate to a 10-in. steel pipe to provide the column and column face respectively, and also welding a plate on the bottom to obtain a column foot for fastening to the base. The strength of this built-up-section column is obvious.

Aluminum's field appears to be largely in transportation equipment and for units which must be moved. Duff-Norton has produced a light-weight journal jack of aluminum, weighing 40 per cent less than the conventional unit, and also capable of resisting corrosive atmospheres. Weight reduction of 40,000 lb. is incorporated in the new design of aluminum high-speed multiple-unit trolley cars developed for the Indiana Railroad system. These cars run in excess of 70 m.p.h., are arranged for one-man operation, have low stream-line bodies and oval roofs, flush-type doors, and are divided into compartments. 46 ft. long between bumpers, the cars weigh 50,000 lb. and are driven by four GE 100-hp. 600-volt motors on Commonwealth cast-steel trucks of the drop-equalizer type, permitting lowered center of gravity and consequently less sidesway. Inside finishing is also in aluminum sheet, spotwelded, while equipment supports are aluminum pressings, forgings or tubing.

Suction-type dust collectors for rock-drills, developed as a health measure in excavating for the Metropolitan Life addition in New York, unexpectedly increased the rate of drilling about 15 per cent, explained by immediate carrying away of dust instead of permitting it to be reground by the drill. This opens the way for drills with increased rock-drilling speeds.

The trend toward all a.c. equipment for power continues. Ford has just changed over 27,000 d.c. motors for a.c. He also has installed some new 4-speed motors.

A new midget radio, the first "universal," is equipped to operate on either a.c. or d.c. and uses the 6-volt automobile radio type tubes. Battery operated sets become more numerous as engineers endeavor to produce radios that will sell to farms. About fifteen manufacturers now make them. The "home entertainment" trade wants and needs a good non-automatic $150 combination, possibly a tip for radio engineers. An automatic switch has been announced for shutting off the radio when the telephone receiver is lifted and putting it on again when the receiver is replaced. Some radios now have coin-operated meters to provide a given amount of radio for a coin. Now comes an automatic "installment collector," placed beside an electric refrigerator, which permits daily refrigeration when the daily installment is placed within it.

Is the factory-made metal house one of the new products to come out of the depression? Dwelling houses with fabricated steel frames have been going up in New York and Cleveland suburbs, but a German firm and a French company have gone further and developed standard box sections which permit most of the work to be done in the factory. The success of this new industry will depend entirely upon public acceptance of the designs, since the idea is eminently practical mechanically.

BOOKS FOR ENGINEERS

A History of Aircraft. *By F. Alexander Magoun and Eric Hodgins. 495 pages, 6¼x9¼ in. Cloth-board covers. Indexed. Illustrated. Published by Whittlesey House, 370 Seventh Ave., New York, N. Y. Price $5.*

ENGINEERS who have no connection at all with the aviation industry will find as much inspiration in this easy-reading book as the airplane designer himself. The inspiring story of the men who worked against great odds over a period of a century to accomplish the miracle of human flight ought to be an encouragement to any product engineer. Langley, for example, had a brilliant idea, but there was no suitable motive power in those days nor any of the light-weight metals afterwards developed. However, what he and his assistant were able to accomplish opened the door to future progress.

Wood in Aircraft Construction. *By George W. Trayer, engineer, Forest Products Laboratory, U. S. Department of Agriculture. 274 pages, 6x9 in. Published by the National Lumber Manufacturers Association, Washington, D. C. Price $2.50.*

ALTHOUGH intended primarily to serve engineers engaged on aircraft work, this little volume forms an excellent treatise for anyone having to do with wood for any products where the physical properties of the woods must be considered. It first describes briefly the distribution and supply of the various kinds of woods so far employed in airplane construction, and then in another chapter takes up the strength, selection, and suitability of the woods. A chapter is devoted to the methods used in seasoning, bending, gluing, and protecting the woods. A chapter on methods of calculating the strength of airplane parts gives the designer a comprehensive outline of the formulas to be applied for all ordinary strength calculations.

Unusual Experiences In Designing Machine Elements

The chief engineer of the world's largest elevator plant relates some of the peculiar problems encountered in designing shafts, bearings, brakes, couplings, and other parts, and explains how the difficulties were overcome

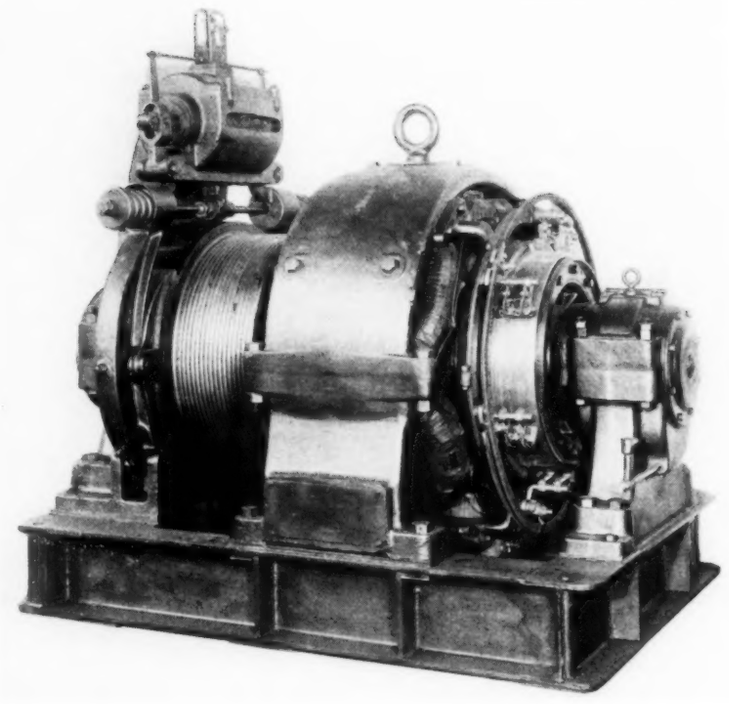
An Interview with

DAVID L. LINDQUIST

Chief Engineer, Otis Elevator Company

MANY problems of a general nature were encountered in the development of high-speed elevators and many of the principles have a broad application. Thus, it was necessary to make a considerable study of noises and their causes. It would have been ideal to determine the amplitude and frequency of the vibrations that give rise to unpleasant sounds, but it was soon discovered that the problem could not be solved on such a basis. Either of two different noises alone might pass unnoticed by the passengers in an elevator cab, but with both noises present the result might be nerve racking. This condition might be compared with color combinations; certain colors blend, others clash. Again, a comparatively slight noise of a certain tone might be extremely disagreeable, whereas another sound many times louder would not cause any complaint. The only feasible solution to this problem in the case of passenger elevators was to eliminate all sources of noise in so far as it was possible to do so.

Gears, such as would be required in a high-speed elevator drive, would be a source of noise. Therefore, gearing was entirely eliminated and the cable drum was mounted directly on the armature of the motor. This apparent simplification immediately gave rise to a number of perplexing engineering problems. With the tremendous load that comes on the armature shaft, special precautions had to be taken to minimize deflection. Originally, the armature spider was pressed lightly on the shaft, bearing against a flange at one end and being held by a nut on the shaft at the other. It was soon discovered that the armature spider would creep over toward the bearing farthest from the cable drum, shearing the threads of the nuts that were supposed to hold the spider axially. It was finally decided, after attempting to use larger and heavier nuts, to press the spider on the shaft with a force fit. At first a pressure of 50 tons was used, and as an additional precaution a heavy



GEARLESS traction motor mounted on its base. Brakes are released only when the solenoid is energized

nut was applied to lock the spider against the shoulder of the shaft at the opposite end. This, however, was not sufficient to overcome the difficulty, therefore higher force-fit pressures were employed. Finally, a pressure of 100 tons was used and in addition an extremely heavy locking nut.

In the meantime a study was undertaken to determine why the spider crept on its shaft. It was analyzed as being caused by the deflection of the shaft and, incidentally, it was discovered that the higher the press-fit pressure the greater would be the axial force set up tending to make the shaft creep and shear off the threads of the nut.

Why the deflection of the shaft should cause the spider to creep can be understood readily when one considers what is happening. The armature is of course rotating, and its shaft is deflected mainly by the heavy load on the cable drum. Now consider the surface on the bottom side of the shaft at the drum end of the spider. The deflection has greatly diminished the pressure at this point between the shaft and the spider. Also, the longitudinal fibers on the surface of the shaft at this point are in tension. Following this point around as the armature rotates, the pressure between the shaft and spider constantly increases and the tension changes to compression, this last requiring the surface particles to move in an axial direction away from the cable drum, thus tending to push the spider in the same direction. The forces are extremely large, and unless the grip of the spider is great enough and the nut strong enough, a minute motion will take place. This repeated 60 to 120 times a minute will in a relatively short time displace the spider an appreciable distance.

By increasing the press-fit pressure to 100 tons and using a very heavy nut, the creeping was eliminated. But this was not a really satisfactory solution. It was therefore decided to make the shaft and spider as a single unit by using a hollow steel casting. This gave the much desired rigid construction, was relatively light, and put an end to all danger of the spider creeping. On the other hand, this change brought with it other unexpected problems.

Oil seeped into the inside of the hollow casting, evidently coming from the bearing lubrication. These bearings are relatively large, eight or even ten inches in diameter. They are designed for an average pressure of 400 lb. per sq.in. on the projected area, actual unit pressures between the bearing surfaces greatly exceeding this amount. Allowing for overloads, the maximum oil film pressure momentarily may run higher than 1,200 lb. per sq.in. Tests showed that oil under such pressure would seep through the steel casting if it were at all porous. Therefore, close-grained electric steel was specified, and as an additional precaution, it was specified that each casting be tested hydraulically at 600 lb. per sq.in. This eliminated leakage of oil to the inside of the armature.

One may wonder why anti-friction bearings were not adopted. They would have eliminated the difficulties resulting from the oil-film pressures on the journals. But, as mentioned before, noise in an elevator is not permissible. With journals 8 or 10 in. in diameter, and at 120 r.p.m., the high rolling speed in anti-friction bearings would create some noise. This could possibly be eliminated by using extra large rollers or otherwise specially designed bearings, but the expense would be such that it was not considered feasible.

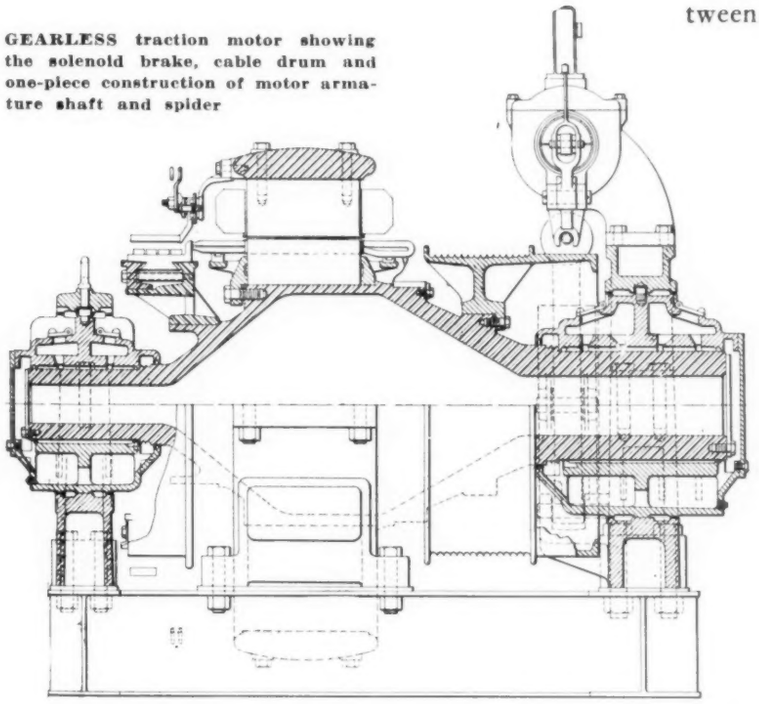
Plain babbitt bearings with chain lubrication are used. On account of the high pressures involved and the frequent starting, the bearing metal must be soft enough so that it will not abrade before the film of lubricant has been established. Babbitt will not score even when relatively

dry of lubricant, as it will flow rather than abrade. At the same time, a hard wear-resisting surface is desired. Babbitt fills these two requirements better than any other bearing metal tried on elevator motors, and therefore was adopted.

At present, the motor bearings are chain oiled. But the service required of elevators is becoming more severe. Speed and load are increasing and it is possible that forced lubrication, giving a continuous oil pressure on the bearing will have to be adopted so that a complete lubricating film will always be present, even when the motor is not rotating.

Brake pulley and cable drum are cast in one piece and attached to the armature by means of a male and female shoulder fit, as illustrated. This casting cannot be made of steel because of the higher rate of wear on the steel hoisting cables. As elevator cables must be discarded as soon as decreased strength is evidenced by broken wires or abrasion, it is important that the cable drum be designed for minimum wear on the cables.

GEARLESS traction motor showing the solenoid brake, cable drum and one-piece construction of motor armature shaft and spider



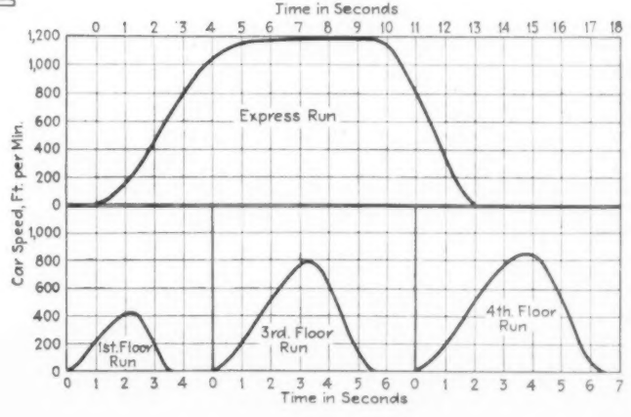
Ordinary cast iron is not suitable as it would be crushed by the heavy loads. Therefore, semi-steel is being used, since it has the necessary strength and does not abrade the cables. But with the ever-increasing load, it is beginning to be questioned whether this material will be satisfactory for future application. However, semi-steel is well suited for the brake pulley.

In the course of the development of this design of cable drum and brake pulley, another interesting problem was presented by the failure of the bolts holding the cable drum and brake pulley to the armature. The drum was made a snug fit on the armature and the bolts were designed to transmit the required torque between the drum and the armature. The diameter of bolts used was such that the shearing stress across the bolt was not more than 2,000 lb. per sq.in. But in spite of the low unit stress, the bolts sheared off at the joint. It was assumed, because investigation showed some of the bolts to be loose fits and others tight fits, that the shearing resulted from uneven distribution of the load. Therefore, it was decided to ream the bolt holes and use body-fit bolts. This would insure all of the bolts taking an equal load. But it did not rectify the trouble. As a matter of fact, the body-fit bolts sheared through more quickly than the loose-fitting bolts.

A more intensive study revealed the cause of the failure. During operation of the elevator the heat from the motor and the heat generated when braking caused expansion of the cable-drum casting. This created a gap between the cylindrical surfaces of the male and female joint between the armature and drum, thus throwing the full load of the cable drum on the bolts. As these bolts were designed to withstand only the torque to be transmitted, they naturally failed. The solution of the problem was simple enough. The cable drum was given a shrink fit on the armature, compensating for the expansion caused by the heat.

It is apparent that all of the masses suspended from the drum must be made as light as possible in order not only to minimize the dead weight but also to keep down the forces required for acceleration. With the increasing height of skyscrapers, the weight of the steel

TYPICAL speed-time curves of an automatic signal control elevator. Duty: 3,500 lb. at 1,200 ft. per min., 80 story rise


Time in Seconds
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
1,200
1,000
800
600
400
200
0
Express Run
Car Speed, Ft. per Min.
1st. Floor Run
3rd. Floor Run
4th. Floor Run
0 1 2 3 4 0 1 2 3 4 5 6 0 1 2 3 4 5 6 7
Time in Seconds

cables plays a more and more important part. Cable manufacturers have now developed their product to an extent where they are able to furnish cable having a tensile strength of 260,000 lb. per sq.in. and higher. Manufacturers of wire ropes for elevators are undertaking further research, and it is expected that in the near future they will be able to furnish a still more highly developed product.

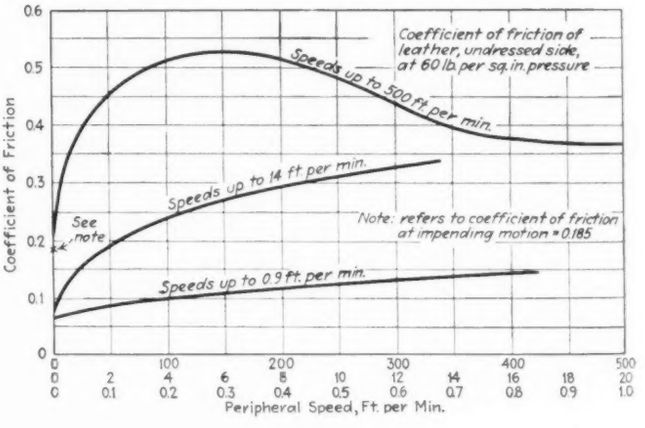
Solenoids are used to operate the brake shoes on the brake. The steel brake shoes are lined with asbestos, instead of the leather formerly used. The reason for replacing the leather lining with asbestos is because of a peculiarity in the speed-friction curve of leather.

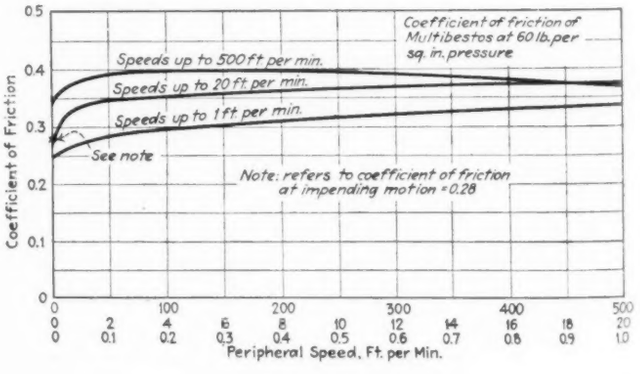
In the course of making tests, a group of engineers had taken an elevator to the third floor of one of the buildings of the Otis plant at Yonkers, N. Y. They left the elevator supposedly standing at the third floor. Returning sometime later, they discovered that the elevator had moved several feet from the landing. It was first assumed that someone had taken the liberty of using the test elevators, but investigation revealed that the power had been shut off. It was then decided to find out if by any possibility the elevator had moved of its own accord. A test showed that with suitable load, the elevator would creep at a rate of about 1 ft. per hour. Evidently the brakes, which were lined with leather, were not holding. Experiments were then undertaken to determine the coefficient of friction of various materials on cast iron, at various speeds and temperatures. About twenty-six different materials were tested and speed-friction curves plotted.

Particular attention was paid to the coefficient of friction at very low speeds. It was discovered that all friction materials showed an appreciable drop in the coefficient of friction at such low speeds, that is, speeds in the neighborhood of a few feet per hour. When sliding ceased entirely, that is at zero velocity, the coefficient of friction immediately jumped. This was found to be true to a greater or lesser extent in all of the materials tested against cast iron, but in the case of leather it was found that the coefficient of friction at very low velocities dropped to about one-half of the coefficient of standing friction, whereas in the other substances there was a drop of only about 10 per cent. A drop in frictional resistance as the velocity approaches zero is desirable, but the extreme drop shown by leather was detrimental because it made the action of the leather brake lining uncertain. Thus, if for any reason a slight movement or vibration of the drum were induced in a standing elevator having leather brake linings, the frictional grip of the brake would immediately drop to less than one-half of the stationary braking power, and the elevator might continue to creep downward indefinitely. For this reason it was decided to substitute asbestos brake lining for the leather.

Most of the braking in stopping the elevator is done by the motor regenerating current, that is, dynamic braking. Elevator motors are not only reversing but must also operate as a motor or generator in either direction of rotation. For gearless elevators, they are slow-speed motors operating at 60 to 120 r.p.m., corresponding to elevator speeds of 600 to 1,200 ft. per min. The starting torque is very high; starting power peaks of high-speed elevators may be from 2 to 3 times the power taken when hoisting at full speed with full load in the car. However, with multi-voltage control these peaks are of very short duration, from one to two seconds, even when hoisting full load. Maximum current peak in elevator motors occurs during the period of regeneration when retarding the elevator at full load.

The amazing smoothness with which modern


Coefficient of Friction
Coefficient of friction of leather, undressed side, at 60 lb. per sq. in. pressure
Speeds up to 500 ft. per min.
Speeds up to 14 ft. per min.
Speeds up to 0.9 ft. per min.
See note
Note: refers to coefficient of friction at impending motion = 0.185
Peripheral Speed, Ft. per Min.


Coefficient of Friction
Coefficient of friction of Multibestos at 60 lb. per sq. in. pressure
Speeds up to 500 ft. per min.
Speeds up to 20 ft. per min.
Speeds up to 1 ft. per min.
See note
Note: refers to coefficient of friction at impending motion = 0.28
Peripheral Speed, Ft. per Min.

FOR very low speeds, the coefficient of friction of leather against cast iron drops to about 35 per cent of its maximum value, whereas with asbestos type of lining on cast iron the decrease is only to about 70 per cent of its maximum value

high-speed elevators start and stop is often commented upon. It is obtained by designing the elevator driving apparatus and control so that the elevator car will be properly accelerated and retarded, as exemplified by the accompanying velocity-time diagrams. Near the start the rate of increase in acceleration is constant as represented by the equation:

$$\frac{d^2v}{d\,t^2} = \text{constant}$$

From standstill, the acceleration increases at a constant rate until, at the end of about $\frac{3}{4}$ sec., the maximum rate of acceleration, about 7 ft. per sec., per sec. is reached. This rate of acceleration then remains constant until a considerable percentage of full speed is attained, when a constantly decreasing rate of acceleration begins, continuing until practically full speed is reached. Theoretically, the elevator will never reach a constant maximum speed. When the elevator is being brought to a stop, the reverse sequence of operation takes place. The maximum rate of deceleration is about 10 ft. per sec., per sec. Human comfort permits a higher rate in stopping than in starting.

The importance of visualizing realities and facing facts as facts, too often is overlooked by engineers. Theories have limitations: actual conditions do not always conform to those which are assumed: and there is often extreme variability in factors that are usually considered constant. In this story can be seen how vital is reality in engineering problems

The acceleration of the elevator car is automatically constrained to the desired velocity-time curve by suitable control of the action of the magnet contactors and the inherent time constants of the generator and elevator motor fields. In modern elevator operation each motor is supplied with its electrical energy from an individual motor generator set. These supply regulated voltage for acceleration and retardation, which results in smooth operation and accurate control. This type of control is equally well adapted to alternating or direct current and the performance of the elevator is the same with any supply.

Seconds count in loading and unloading the passengers, but safety cannot be sacrificed. Thus, the old pantograph or grill type car gate was a source of danger and slowed operation. The operator had to look carefully to see that no passenger had a finger on the gate before it was opened. With the advent of higher speeds, the closed car came into existence. This eliminated draft, dust, and the danger of the pantograph gate. It also made the passengers oblivious of the high speed, and shut off the view of the unattractive hatch and the floors flitting by.

Flush doors are preferable, but if the architect or owner is too persistent, a panel not more than $\frac{1}{8}$ in. deep may be used. But the ideal is a flush surface so that there may be no possibility of jammed fingers. Also, for highest speed of service, center-opening double doors are used. The sliding speed of the door is not limited by mechanical conditions, but rather the maximum speed with which a passenger may be hit by the door without being injured. Thus, the double doors give twice the rate of opening for a given sliding speed. Similarly, the doors are made largely of aluminum to minimize the impact should a passenger accidentally be caught in the door. In the fastest elevators only 1 sec. is required for opening the door, but the closing time is $1\frac{1}{4}$ sec., this representing the maximum speed at which a passenger would not be injured if hit. Incidentally, for a given speed of opening, a single door would have 4 times the impact of that of a two-panel center opening door.

Wood veneer is used for trimming the inside of elevator cars. The principal reason is that wood is much easier to refinish, whereas coated metal not only shows up scratches but is also more difficult to refinish satisfactorily.

In modern skyscrapers, where time is important in the operation of the elevators, the cars are made automatically self-leveling, the car door and corridor door open automatically, these operations taking place simultaneously.

Safety, speed, and silence are the three factors in elevator design, and the biggest element in the whole problem is human behavior. Safety must be fool-proof to the extent that it will be almost impossible for a person to be hurt. Speed must be the maximum, but the passenger must be oblivious of it. Smooth silent operation is paramount for the peace of mind of the passenger. Yet people complain about a sense of "imprisonment" in closed elevator cars, and others who meekly tolerate the bangs and screeches of the subway will report a squeak in "the lift." Such is the task confronting the designers of elevators.

✦ ✦ ✦

Higher Priced Materials Without Added Cost

Merely to substitute a new material for an old is to miss half the new material's value. By making full use of the die-casting properties and designing to save machining and assembly costs a superior article was produced

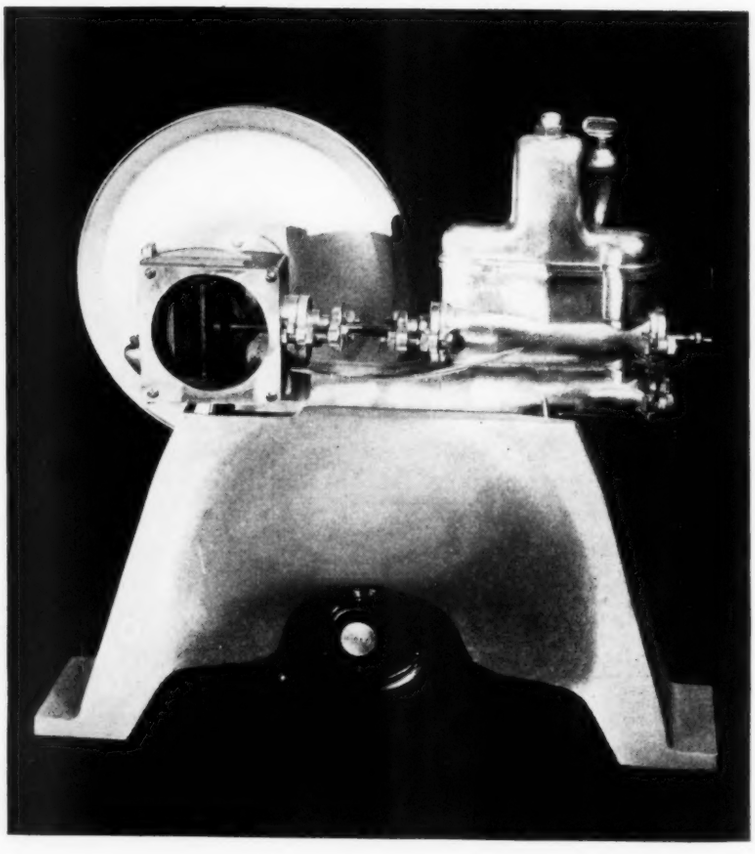
By Le ROY H. LABAW
Chief Engineer,
L. R. H. Labaw and Company

DETERIORATION, mechanical troubles, corrosion of ports and passages, and increasing cost of operation as the unit becomes older are eliminated in motor-driven domestic pumps by the use of a rust-resisting material. However, the price of pumps of brass, aluminum or similar materials would be prohibitive unless the new material made possible a simplified design on which we could realize substantial savings in manufacture.

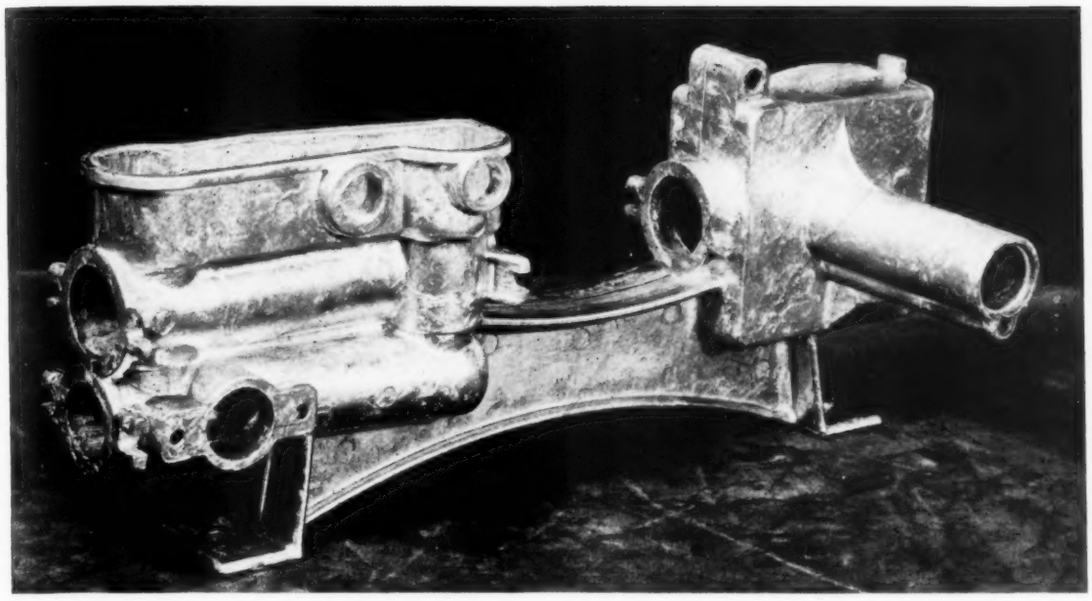
Still, many troubles arise from the use of cast iron for pump bodies. Rusting soon begins, and a heavy coating of scale partially closes ports and passages. The cost of operation of the pump increases and more frequent repairs become necessary. Further, even though an iron casting be cleaned, recleaned after machining, and then painted, sand and iron particles become loosened in service and present a constant hazard to the life of moving parts.

The need for simpler manufacture to keep down price immediately suggested die castings; aluminum alloys were chosen as the corrosion-resistant material. The final analysis showed that it would be most desirable to die cast not only the cylinders but the entire water end, pump frame, and crank end in one piece. Such a die casting would, of necessity, be quite large, requiring intricate and expensive dies. However, there were so many advantages that it was decided to develop such a pump.

The new product, following conventional lines, was to be a double-acting, reciprocating, single-cylinder pump having two crimped leathers for the piston, and rubber suction and discharge valves. With a $1\frac{5}{8}$-in. stroke and $1\frac{1}{4}$-in. diameter cylinder, and operating at 240 r.p.m., the pump would have a capacity of 250 gal. per hour, which



OTHER than the valves, rods, and bolts, all parts of this pump are die-cast



ONE-PIECE die castings eliminated expensive machining and assembly operations and resulted in a rigid unit with surfaces inherently aligned

a study of the market showed to be the most desired capacity. In order to meet the demand for a larger capacity pump, about 450 to 500 gal. per hour, it was decided that the need could be met without adding to the expensive manufacturing facilities by using a double-shaft motor with a pulley on each end and placing a pump unit on either side. Suctions and discharges would be connected together to form single suction and discharge lines. It would then only be necessary to furnish a different motor bracket.

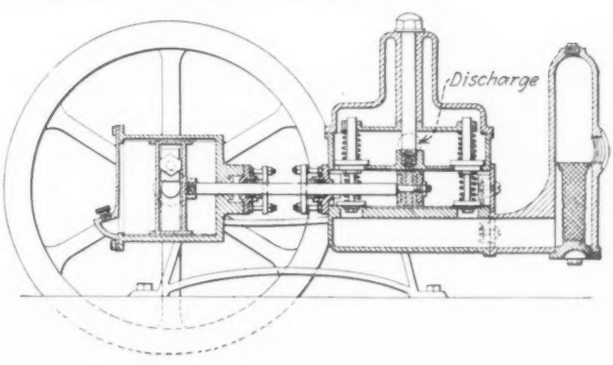
A 90-10 aluminum-silicon alloy was selected for the die-casting. The cylinder was the first problem. The material was not sufficiently hard to resist piston wear, so we inserted a brass liner. It is common practice in cast-iron pumps to insert the liner after the casting has been machined. Here, however, the cylinder liner is a piece of brass tubing placed on the core of the casting die. The subsequent shrinkage of the die-cast metal holds the tube more firmly than any mechanical insertion can, and also eliminates machining expense, while providing a harder cylinder wall.

The water end design presents many advantages. Suction and discharge valves are placed one directly above the other, the head-end valves being on the center line of the cylinder while the valves at the crank end are offset to permit clearance for the piston rod. The suction valve is made slightly smaller in diameter than the discharge valve port. The discharge valve bonnet is located by the same stud bolt that fastens the discharge chamber. To get at the valves it is only necessary to take out one bolt and break the gasketed joint between the discharge chamber and the pump cylinder castings. The valve bonnet may then be taken off and discharge and suction valves lifted out. With the discharge and suction valves one above the other, there is no reversing of the flow.

In the design of the aluminum die-cast discharge chamber the inside boss for the bolt hole is carried down to the top of the valve bonnet so that there is no joint through which air may leak from the discharge air chamber. Joint surfaces of the discharge chamber and the top of the cylinder are smooth and true when the parts are die-cast. A gasket makes the joint water-tight. In die casting the cylinder block a very thin slot is cast radially into the valve seat so that water may trickle back under the discharge valve and into the cylinder when the pump is stationary. This prevents air binding as long as there is water in the discharge chamber.

In order to give the pump maximum capacity for discharging air from the cylinder when starting, the aluminum die-cast heads have an internal boss so that the head and crank clearances will be minimized, it being seldom required to prime the

THE Scotch yoke eliminates connecting rod, guides, and crosshead, thereby also shortening the pump considerably. Made of aluminum die castings, the unit weighs only 52 lb. and is free from rusting



pump. By using slotted lugs, studs or tap bolts are eliminated and ordinary commercial bolts and nuts substituted. Carrying out the idea of corrosion resistance, the piston rod is made of stainless steel. It is specified with a mirror-like finish which cuts down leakage at the stuffing box.

Steel inserts provide bearing surfaces for the crosshead. By using a Scotch yoke mechanism, the connecting rod is eliminated, and a die-casting is made possible for the pump and frame because of the space saving. Steel inserts in the yoke or bearing block provide wear resisting bearing surfaces for the crankpin. The yoke is split in a manner similar to the cap on the closed-end connecting rod of an automobile engine, so that wear may be taken up.

The crankshaft is a straight, $\frac{3}{4}$-in. diameter, carbon-steel bar having a disk cast on the crank end. After cooling, shrinkage over the coarse knurling makes this practically a one-piece construction. The crankpin is also coarse knurled at one end aand cast into the crank in the same operation. This assures perfect alignment of these parts without expensive machining jigs.

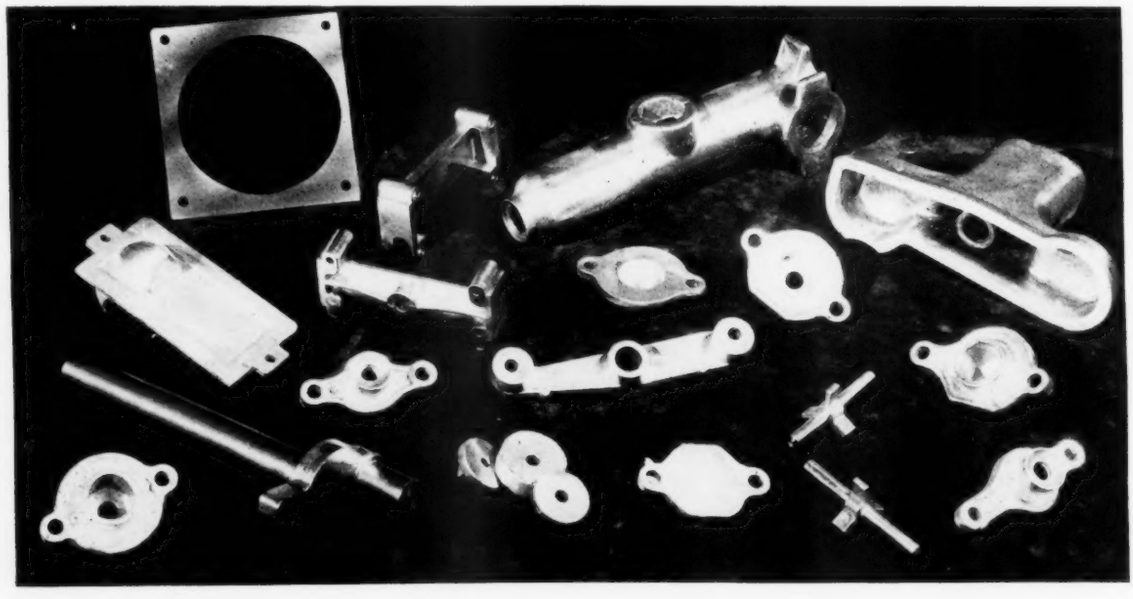
On the opposite end of the crankshaft is mounted a flywheel with a V-groove rim, driven through a V-belt by the electric motor running at 1,750 r.p.m. Although a $\frac{1}{6}$-hp motor would be sufficiently large, a $\frac{1}{4}$-hp. motor is used. It costs little more and is about the cheapest motor per horsepower.

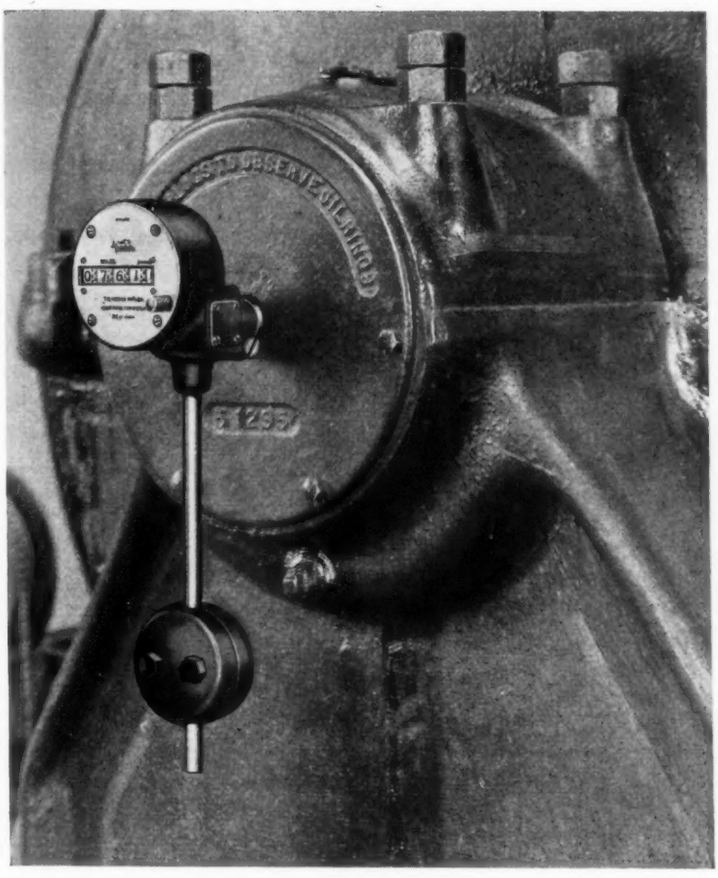
The crankcase is totally inclosed, the cover being fastened with drive screws to obviate tapping of the holes. The cover has a celluloid front, making the operating parts and oil level visible. The crankcase end plate has a boss and oil plug at such a level that only the proper amount of lubricant can be put into the crankcase, any excess overflowing.

The rear wall of the crankcase has a long cored boss with a brass insert cast in to form the crankshaft bearing. In order to prevent oil from leaking through the bearing and out at the flywheel end, a cored hole about $\frac{3}{16}$-in. in diameter, directly below the boss, serves as a duct to drain back into the crankcase the oil that has leaked through the bearing.

By making full use of die-cast design, most machine work was eliminated. Also, there is no necessity for cleaning castings. Unit construction eliminates the expensive assembly operations required to obtain perfect alignment of the cylinder and cross-head bore, as well as the exact angle to the crankshaft. Use of the Scotch yoke construction decreases the number of bearings and wearing parts. For these reasons, the manufacturing cost of this design of aluminum die-cast pump is no more than that of the former cast-iron pump. In addition, the use of die-castings results in a product having a permanently attractive appearance. Painting is not necessary.

In the development of a complicated design it is necessary to procure the cooperation of specialists. In this instance, the required corrosion resistant aluminum-silicon alloy having the necessary casting qualities and physical properties was developed in the research laboratories of the Aluminum Company of America. Design of the dies for casting presented probably most difficulties. In solving this problem and developing the proper casting procedure, we had the assistance of the A. P. Grimm Foundry Company. As a result of close cooperation, perfect castings are being produced economically in this metal.





COUNTER installed on an elevator to record the number of miles traveled

Recording Units Designed In

By HARVEY L. SPAUNBURG
Chief Engineer, Veeder-Root Incorporated

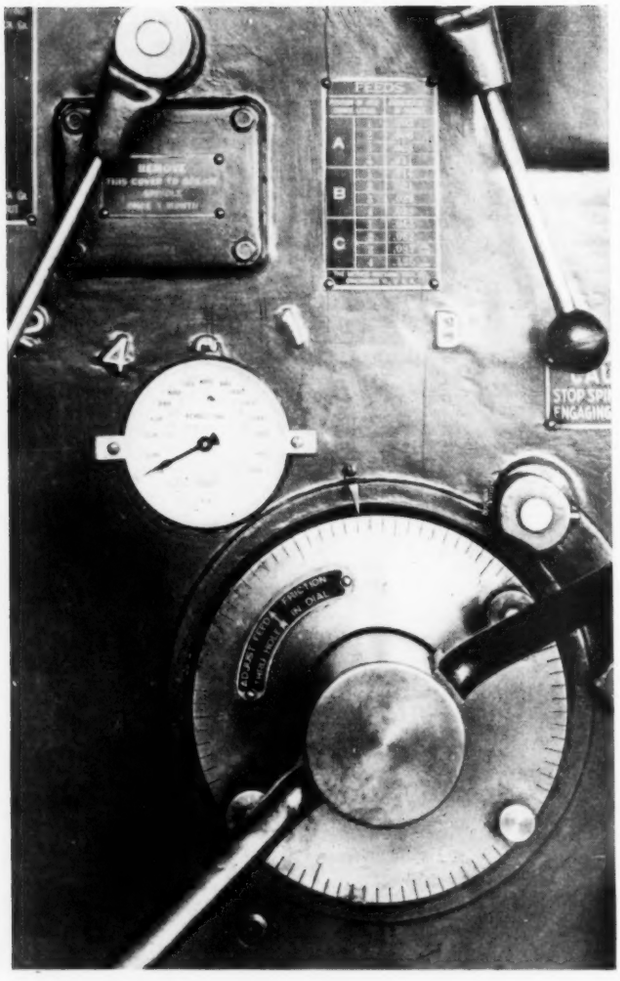
COUNTING instruments for the accurate tallying of output have been manufactured for years, but it is only very recently that they have begun to be designed into the machine as part of original equipment. The early bicycle was equipped with a cyclometer, the forerunner of the present automobile speedometer. Since the first cyclometer the use of automatic counters in industry has grown greatly. Their use has resulted not only in assurance of positive count to protect manufacturers against loss through overruns and underruns, eliminating the costly operation of counting by physical means, but has actually increased production by furnishing an incentive to the workman to produce more work by showing a better record for himself on the counter dial.

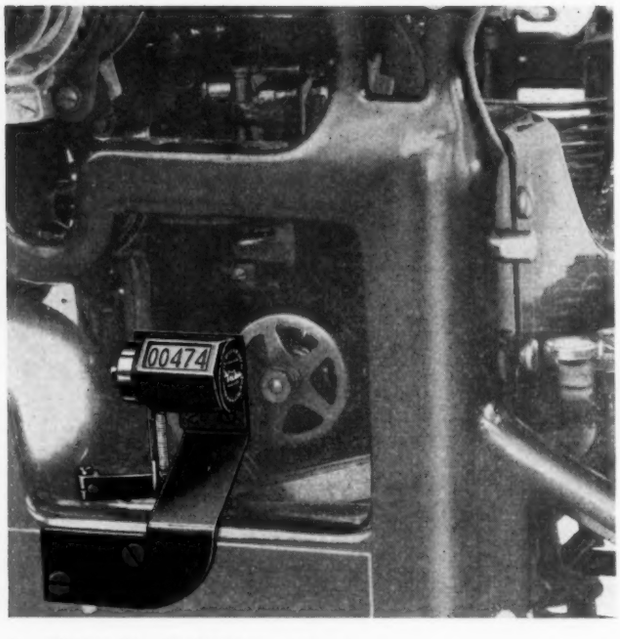
The first large machine use of automatic counting equipment was in the printing industry, and most printing presses today are equipped with some type of recording instrument. The large automatic presses used on newspaper work, as well as lithographing presses, are equipped by the manufacturer of the machine. The counter is installed so as to register only when an impression is made, thereby giving actual count. The jobbing presses have not, until recently, been equipped by the manufacturer, but there is a decided tendency at the present time for this to be done. On jobbing presses counters are installed in such a manner that when the release is off and the press is running without printing, the counter does not record.

The majority of punch presses in use at the present time are also equipped with counters. The counter, when added to the machine in the place of operation, is fastened to the frame of the press in some convenient position so as to be actuated by the ram to which it is connected, frequently only by means of a chain or leather strap. But the most satisfactory installation is one in which the connection to the counter is made with permanent linkage so that the counter can be operated only by tripping the press. A common objection to this type of installation is the possibility of the operator tripping the press without actually producing work, thereby registering on the counter. While this is possible, it has been found by large users to have been very greatly overrated.

For drop hammer use producers of forgings have made time studies to record the exact number of blows to produce each type of forging, and they are able to tell from the counter reading just how efficiently the hammer is being run by the operator.

In much the same manner counters are used on all types of special machinery, such as tapping heads, drill presses, threaders, and packaging ma-





A BUILT-IN tachometer on a radial drill indicates the revolutions per minute the drill must run for a given cutting speed. With this appliance the operator can judge if the feed is too fast

COUNTER installed on a typewriter to measure typebar movements. Counters are also installed on many types of office machines

chines. Screw production is being counted automatically on many types of screw machines. This method of counting production is superior to computing number of pieces by weight because the record is obtained without the expense of labor and also because the record is available immediately at the machine. It is possible for the operators to tell at once how the job stands. Different installations are required on different makes of machines. A new and what seems to be a very practical method is to incorporate in the stock stop a counter which records each time the stock is fed against the stop. Another method is to connect the counter to the feeding mechanism of the machine and record each time the stock is fed. This is open to some objections on those machines not using a knock-off attachment which stops the stock-feeding mechanism from operating when the bar of stock is used up. On multiple-spindle screw machines, the counter is set so as to have the actuating mechanism operated by the stock in the spindle at the operating end when the spindle head indexes. It is, of course, only necessary to have the counter in one position because all of the spindles in turn pass any one given position.

In the canning industry every closing machine is equipped so that at the end of the day a total of the number of cans filled has been recorded. The counters used in this industry are designed especially to resist moisture and corrosion from the steam, hot water, and fruit and vegetable juices which collect on them.

Another important development in recent years has been the magnetic counter. This type of counter works under conditions where a mechanically operated counter is more or less impractical. There are many kinds of contactors which may be used to operate such a counter. They may be installed on various classes of standard and special machinery to count the actual production and their particular advantage is in the possibility of making small sensitive contacts which operate the counter. The counter itself may be placed in some convenient position away from the machine. In some industries, it is desirable to record in the manager's office the actual progress of various jobs going on in the factory. A series of magnetic counters can be conveniently and neatly installed and wired to the individual operations, registering the progress of each job in the central office. Magnetic counters centrally located may be employed in addition to mechanical counters built into the machine.

A recent development has been that of the

so-called "predetermining counter." The predetermining counter is one which can be set to any desired number within its capacity, and when that number is reached, will make or break contact in the contactor which is built integral with the counter. The electrical circuit of which this contactor is a part may be used to ring a bell, light a lamp, or stop the machine. On winding machines for electrical coils, the predetermining counter is almost indispensable. The counter is set at the required number of turns and when this number is reached, the machine is stopped.

It is frequently desired to arrange a machine to produce articles in definite quantities, and under such conditions inexpensive auxiliary equipment can be arranged to remove the package or stop the machine by means of a predetermining counter when the quantity has been produced.

In the textile industry automatic counters have been used for many years. Slubbers, intermediates and spinning frames are usually equipped by the manufacturer with hank counters. Warpers, also, are in most cases equipped with some type of measuring or marking device. In the finishing mill, counters are used to check individual machine production in revolutions, to pay on piece-work or bonus basis, either by yardage or revolutions, to check customers' measurements, to be able to determine the most suitable speed at which to operate, to give machine operators accurate information as to machine production in yards per minute or yards finished in some specific period of time, and to be able to run certain materials at predetermined speeds.

A new type counter which will find great use in all industries but which was particularly developed for finishing mills, is a combined automatic counter and time-recording device. The time-recording device is of the clock-driven waxed-chart type, the record being made on the waxed chart by means of a stylus actuated by the counter. The counter can be arranged to record in any desired unit, yards, pieces, revolutions, etc. and the stylus marks on the chart the time in which the production takes place. Such an arrangement is designed into the machine to control the speed of operation on variable-speed machines.

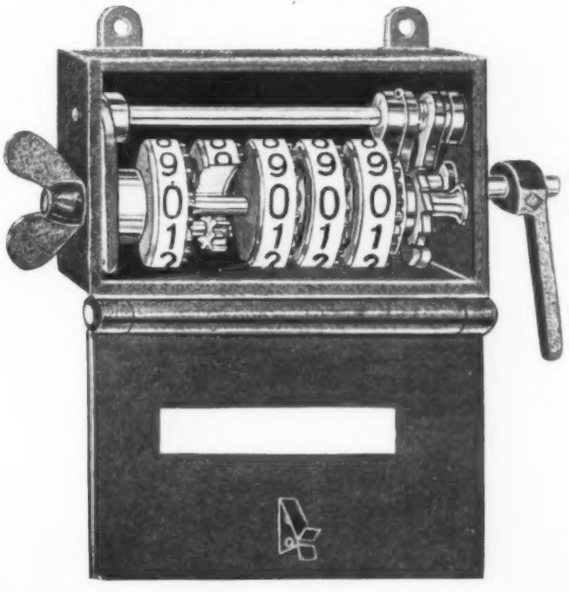
On knitting machines the usual method of arrangement is to count courses or rounds, the counters being driven from the shaft that drives the ring gear. On hemstitching and sewing machines, the counters record the revolutions of the shaft and are geared to read in stitches, yards, feet or any other desired measurement.

A recent development in tachometers, which seems to have much merit, is the tendency for the use of these instruments on machine tools. A tachometer installed on a Morris radial drill press gives on the dial the drill sizes from $\frac{1}{4}$ to $3\frac{1}{2}$ in. and shows at what number of revolutions per minute the drill must run to maintain a cutting speed of 100 ft. per min. Installed on a lathe, the tachometer indicates to the operator any slowing down in speed, thereby allowing him to throw off the feed, thus preventing tool breakage.

In this period of depression here is a company working full time because it has consistently improved its products and ferreted out the places where they could be employed to the advantage of the buyer

Among the latest applications of counters are the elevator mileage counter and elevator stop counter to indicate whether or not building tenants have cause for complaint. The revolution meters now being built into airplane motors record the number of revolutions of the motor, and, indicate to the ground crew when the motor should be overhauled. Formerly, this was determined by flying hours, which did not take into account the idling time. Because of the variety of applications of counters, the need is apparent for the engineer to make provisions in advance in the design of his product to operate the mechanism of the counter from a mechanism of the machine where accuracy will be always assured.

COUNTERS are simple but accurately built mechanisms. Tin-base die castings are used for the small parts and zinc-base for the case



Bargain Psychology in Product

By GEORGE H. KUBLIN
Chief Engineer, Auburn Automobile Company

In January, Auburn startled the industry with five new straight eights. They set a new style in body smartness, offered ample power, comfort with speed, low center of gravity, free wheeling, silent mesh—all at a price under competitive offerings. Depression is unknown to Auburn this year. Shipments for the first eight months were 18,363 cars more than the entire 1930 output. Real product engineering makes sales!

APPEARANCE, performance, price—these are the three chief factors that influence the sale of an automobile today. Appearance justifies the customer's pride in ownership, performance satisfies the urge of getting somewhere quickly and comfortably, and if the price is right, the prospect buys—maybe! It was in this order that we undertook the development of the new 1931 Auburn. First, came appearance, then the power plant was selected to better the performance of cars in the same price class, and lastly the designs were made with the idea of close buying of materials and parts and for manufacturing economies in our own plant. Thus, the sales price could be brought to a level that would appeal to the careful buyer. As a result, sales in a depression year were far ahead of previous records and exceeded our most optimistic hopes.

Experience with the Cord car taught us how important appearance is. We wanted the same appeal in the 1931 Auburn, but it had to be different. Other manufacturers attempted to copy the lines of the Cord, and we did not choose to copy copiers.

The preliminary skirmish with body designs took place not in the drafting room but in the studio-office of our body designer. This man is not an automotive engineer, although he is familiar with the appearance and texture of materials used in automobiles. His job is to create and draw small-scale drawings of cars. These pencil sketches are made on white paper to a scale of one-eighth actual size. Promising looking sketches are colored in crayon, since color schemes are just as important as form.

DUMMIES, all wood but for cloth top, a made up in the engineering departme

When we thought he had something, the idea was presented to the chief executives.

Outside artists also send in sketches from time to time. The company even has a staff of young student artists whose imagination is allowed to run at will. Their orders are to avoid association with automotive engineers, lest their originality be contaminated with conventional ideas. Already, some of their ideas have developed into experimental cars.

The artist's sketch is only a starter, of course. The final design varies in many details from the accepted sketch, but basically the general idea of a long, low body, wide doors and small diameter wheels is preserved. The real battle with body form takes place in our experimental department with wood models or dummies. From the artist's sketch a drawing is prepared to scale, and the key or controlling dimensions given. These include wheelbase, frame height, cowl height, seat and leg room in the tonneau, top height, and the like. This permits full scale drawings to be worked up, and it is on the basis

Development

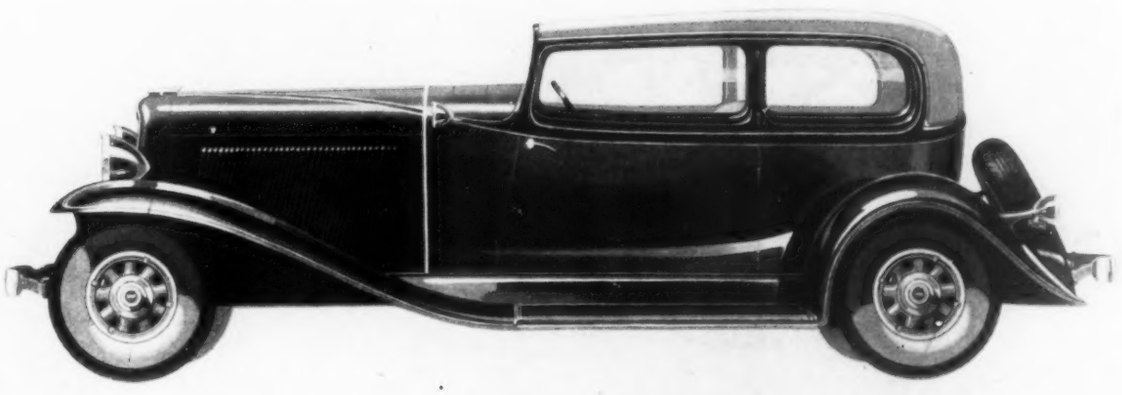
of these that the wood dummy is built. Later, after the dummy is modeled to approved form these drawings are corrected to correspond to the modifications made. From them permanent working drawings are made in ink on an aluminum sheet sprayed white. These are usually kept in the body shops.

Body design, being three dimensional, is really a sculptor's job, and wood is as good a medium to work in as any. It can be cut down to any shape and lends itself equally well to building up with plastic wood or clay. A designer can change his mind twenty times in wood, as we did on the radiator shell alone, without affecting die costs, but once the decision is made and expensive dies built, only a gross error would warrant a change. With the application of paint, cloth top cover, wire wheels and rubber tires, glass windows, cloth interior trim, metal head and tail lights, the dummy bears a striking resemblance to a real car. Fenders, bumpers, rear trunk, tonneau and hood are all wood. Aluminum paint on the radiator shell imitates chromium plate and leather or wood strips make a flexible medium to resemble molding. It is difficult to visualize on paper by projection methods the true shape in space of a warped surface of this type, and the only way to develop a pleasing line is to cut and try until the right effect is obtained.

Most of our major decisions were made while the car was in the dummy stage. Before we finished, the radiator shell had emerged from a shallow V-shape to a slightly concave form. Based on a study of cars in the thousand-dollar price class, and with the thought of giving the public better riding qualities, the wheelbase was raised from 124 in., as originally conceived, to 127 in. Seat arrangement and leg room are largely a question of body overhang on the rear axle. Too much overhang doesn't look well, and can be offset by longer wheelbase. A longer tonneau also permits wider doors, which is a feature that appeals to stout or elderly people. Whether or not the final choice really represents comfort can only be determined by trial. Hence the full size dummies.

At the same time we were striving for roominess fore and aft, we went after side roominess as well. This meant increasing the tread to 61 in., making it the widest of any passenger car then on the market, and incidentally

LONG, low lines, sweeping fenders, small wheels, wide doors—all enhance the "smartness" of the Auburn 8-98 Brougham



adding to roadability and stability of the car, particularly around curves. Obviously, a study of competitive models (bought in the open market) aided our decisions in these and other matters to no little extent. The idea of giving the most car for the money is necessarily comparative.

While these studies in general appearance were going on, parallel investigations were made on the mechanical components of the car. In conformance with the body lines and for maximum safety a low center of gravity was sought. Dropping the wheel diameter to 17 in., an inch below any wheel then on the market, was a step toward this end. Besides, the short, stubby spokes have a smart appearance. Frame design also had to be tied in with it. The use of an X-member accomplished two things: it permitted us to lower the frame and also obtain greater stiffness than by the use of the usual cross channel. By making the center of the X a tubular piece, the propeller shaft can be passed directly through it, instead of below it, saving several inches in frame height from the ground.

For the power plant, we had in mind a car of approximate power, weight and speed. As originally planned, the car was to have an engine equivalent in size to the Auburn 8-90 made by Lycoming, a subsidiary company. This engine size definitely established the distance between the radiator core and the dash, and this was one of the key dimensions placed on the preliminary sketch. When this power plant was compared with those of competitive models, however, and its performance studied in hilly country, it was decided that more punch was needed to make performance count as a major sales factor. Hence the bore was raised to 3 in., increasing the displacement and bettering the torque at the lower engine speeds where it is needed.

The present 8-cylinder motor has a maximum torque of 180 ft.-lb. at 1,600 r.p.m., corresponding to a car speed of 29 miles per hour. The rear axle ratio of 4.7 was chosen in conformance with speed and torque requirements, consistent with the small wheel diameter and vehicle weight.

Some competitive models had synchronized transmission gears, others constant mesh, others free-wheeling, mostly in two speeds forward, or a combination of any two. We decided to put in a transmission that combined all three features, plus the added advantage of free-wheeling in all forward speeds. At the same time we wanted something different in a free-wheeling unit. With this in mind, our company acquired the rights to manufacture a helical spring type free-wheeling clutch that combined simplicity with smooth positive action under all temperature conditions. By mounting this unit at the rear end of the transmission case it is effective in all forward speeds, and a short lever allows it to be locked instantly for driving in positive gear.

Most automobiles are made up of a large number of purchased parts. The new Auburn is no exception. We make our own bodies and sheet metal, and through subsidiary companies, the engine and front and rear axles, also the free-wheeling unit. Frame, transmission, springs, shock absorbers, bumpers, radiator core, steering gear, wheels and tires, motor details, headlights and other electrical equipment, as well as the instrument panel, are all supplied by outside manufacturers. This situation necessitates close coordination between the engineering, purchasing departments, and the sales department, because in every detail there can be built a sales argument

It is no secret that automobile manufacturers are close buyers. They "sit up nights" figuring how they can save a few pennies here and there by substituting parts or taking advantage of the present buyer's market. We bought close, too, but we never lost track of the main idea of furnishing a quality car at an attractive price.

We were not venturing into an unknown field. Auburn had been building automobiles since 1902. This meant we had service and complaint records to consult, also statistical sales information on customer preference as to color combinations, trim, and top material. This information was a big help in parts selection. Our service records, for example, showed that owners of previous models had battery trouble due to winter starting. The engineering department fought for a larger size battery and had its way, although it increased the unit cost appreciably. In this instance price considerations were subordinated to service advantages.

In its various articles, *Product Engineering* has been making valiant attempts to make engineers sales conscious. We think we are already that here. The first sales talk was made by our engineers to our top executives. From it the first advertisement was written. On that occasion, the engineering department put up such a convincing exposition on what it had done and why it had done it, that the performance was repeated a few weeks later before a group of road men. Finally the department became a regular traveling troop, went down to New York and put on a real show, staged with a carload of wood dummies brought

from our laboratory. This included a dozen models of proposed radiator shells, and full size frames of the conventional and X-member type. By anchoring the frames at three points and putting a fixed weight at the fourth, the difference in torsional deflection was apparent. The psychological effect on our dealer organization was fine. These men felt they were being given "straight stuff" from the designers.

The fact that Auburn sales in the first six months of this year exceeded all of 1930 sales is convincing proof of the soundness of our design policy. It proves that if the desires of the public can be gaged correctly, both in the way of appearance and performance, and can be met at the right price, the product will sell, even in an off year. It also shows that the public favors the self-reliant manufacturer who is not satisfied with things as they are and attempts something new.

While the engineering department modestly claims some credit for this sales achievement, it must be acknowledged that the original conception of a bargain car came from the guiding genius of our company, E. L. Cord, described as "an executive who keeps in circulation." He is a man who personally keeps in touch with consumer reaction so as to build the kind of a car the public wants. In his travels about the country in 1930, he noted a sharpened sense of values, and the appeal of a good product at a low price. The engineering department followed through by developing this idea of an automobile.

Oil Systems for Slides

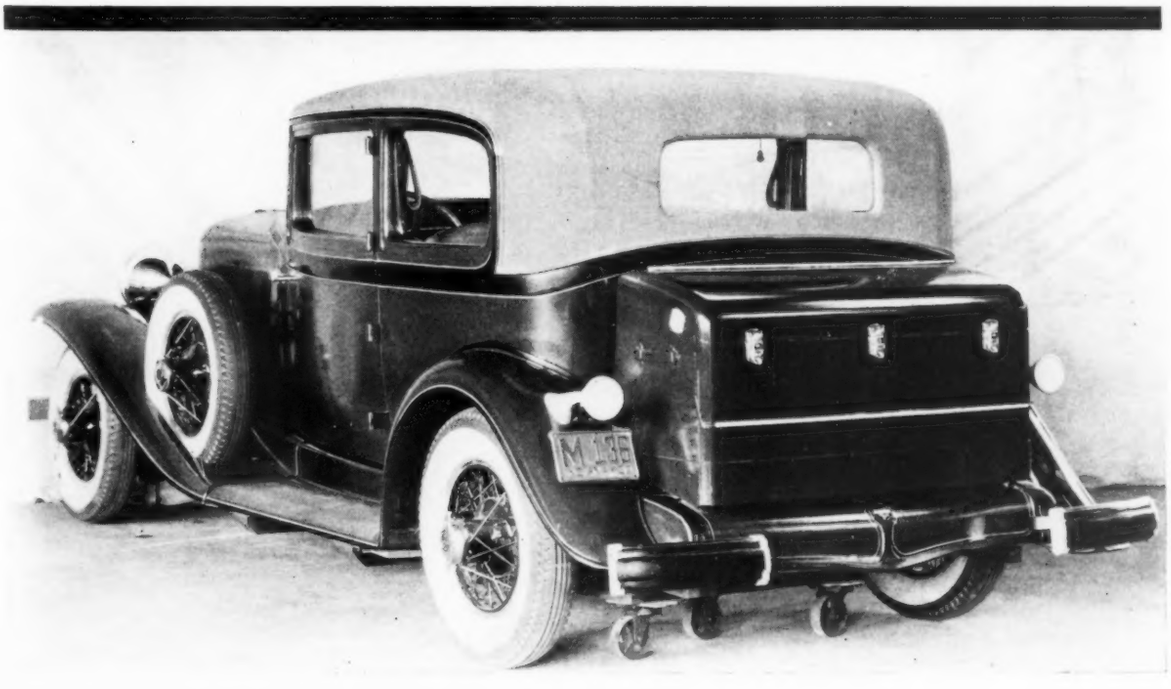
By John E. Hyler

THE paragraph which appeared in the September number of *Product Engineering*, while setting forth the need for positive and continual lubrication of machine bearings, seems to concede that this might not be easily obtained where slides and ways are concerned. Actually, it is no great problem in these days to provide for positive lubrication either to machine slides and ways, or to the bearings.

With regard to the ways, there is the endless bed sanding machine for production sanding on flat surfaces. The traveling endless bed supports the material as it passes through the machine, the sanding drums being mounted above. Wide, replaceable cast-iron ways are provided in the base of the machine, over which run a number of steel lags, which compose the traveling bed. Upon these lags are mounted rubber pads, which have all of their tops lying in a common plane, and furnishing traction to the feed without marking the stock.

The oiling of such a mechanism was quite a problem before the day of the force-feed oiler, for the travel of the bed was always in the same direction, thus tending to carry the oil away from the front end of the ways. Now a continual, though small, supply is provided for the front end of these ways, and the travel of the bed carries enough oil to the back of the ways to keep them lubricated their entire length, thus providing a positive and dependable lubrication.

FULL SCALE dummies are built in wood to give a true conception of the finished product before the car goes to production



Deflection in Shafts of Variable Cross-Section

By E. S. AULT
Associate Professor of Machine Design, Case School of Applied Science

FREQUENTLY in machine construction the deflection of a shaft is of considerable concern. Although strength may be ample, excessive deflection of the shaft in a heavy crusher, a punch press, or a motor-generator may adversely affect the proper functioning of the machine.

Deflections for shafts of uniform cross-section with loads concentrated or uniformly distributed may ordinarily be solved by formulas found in textbooks. Usually, however, the shaft is not of a uniform section but is made up of lengths of different diameters or may have some portions tapered. It is then necessary to develop the relations of deflection to loading for the conditions encountered.

Analysis for deflections within the elastic limit may be made in several ways, the easiest method being selected for solving the particular problem presented. The deflection of a point on a beam of variable cross-section is usually found by double integration of the differential equation of deflection, or by use of the bending moment diagram, known as the method of "elastic weights." The first of these demands some familiarity with the calculus, but the second involves only simple calculation, or may be done almost entirely by graphics.

The method using double integration of the differential equation of deflection starts with the basic equation relating the physical characteristics and deflection conditions of a beam bent by moments only, which is:

$$\frac{1}{r} = \frac{-M}{EI}$$

$$\text{or: } \frac{d^2y}{dx^2} = \frac{-M}{EI}$$

where

r is the radius of curvature of the deformed axis of the beam

M is the bending moment (positive when top fibers of beam are in compression)

E is the modulus of elasticity

I is the rectangular moment of inertia of the cross-section of the beam

$\frac{d^2y}{dx^2}$ is the second derivative of the deflection, y, (positive when measured downwards) with respect to the distance, x (positive when measured to the right)

M is a function of x and if E and I are constant $\frac{d^2y}{dx^2}$ is a function of x. Integrating the above expression the first time we get:

$$\frac{dy}{dx} = \text{some function of } x + \text{a constant } C_1$$

The slope of the deflection curve is $\frac{dy}{dx}$ and if we know the value of the slope at some point x we may substitute these values of slope and x in the above equation and solve for C_1. If no value of the slope is known, C_1 must be carried through the next integration, which resolves into:

$$y = \text{some function of } x + C_1x + C_2$$

If C_1 has been found previously we need to know only one value of the deflection in order to obtain C_2. If both C_1 and C_2 are unknown, additional equations are necessary.

This last equation for y in terms of x is called "the equation of the elastic line" and allows us to determine the deflection of the beam at any point.

If the cross-section of the beam varies according to some function of x, the moment of inertia, I, can be expressed in terms of x; and with the bending moment, M, expressed in terms of x, it is possible to integrate in the form

$$\frac{dy}{dx} = -\frac{1}{E}\int\frac{M}{I}$$

For a simple illustration, suppose a tapered

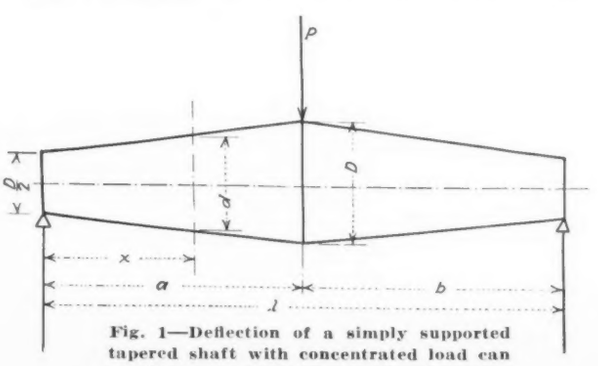


Fig. 1—Deflection of a simply supported tapered shaft with concentrated load can readily be calculated by the formulas presented

shaft, shown in Fig. 1, to have simple supports and a concentrated load at the mid-point.

The diameter, d, at any point x, where x is less than $\frac{l}{2}$, is obtained from the proportion

$$\frac{d}{\frac{l}{2}+x} = \frac{D}{l}$$

or

$$d = \frac{D}{2l}\ (l + 2x).$$

$$I_x = \frac{\pi D^4}{64(2l)^4} \times (l+2x)^4 = I_{max}\left(\frac{l+2x}{2l}\right)^4$$

$$M_x = \frac{Px}{2}$$

$$\frac{d^2y}{dx^2} = \frac{-Px}{2} \times \frac{1}{E\,\frac{\pi D^4}{64}\left(\frac{l+2x}{2l}\right)^4}$$

$$\frac{dy}{dx} = \frac{-256Pl^4}{\pi D^4 E}\left[\frac{l}{6(l+2x)^3} - \frac{1}{4(l+2x)^2} + C_1\right]$$

From the symmetry of the beam and loading the slope of the tangent to the deflection curve at midpoint is known to be zero, hence:—

$$\frac{dy}{dx} = 0 \text{ when } x = \frac{l}{2}$$

Therefore,

$$C_1 = \frac{-1}{6(2l)^3} + \frac{1}{4(2l)^2} = \frac{1}{24l^2}$$

Substituting this value of C_1 in the above equation and differentiating, we get:

$$y = \frac{-256Pl^4}{\pi D^4 E}\left[\frac{-l}{24(l+24)^2} + \frac{1}{8(l+2x)} + \frac{x}{24l^2} + C_2\right]$$

The deflection at the left support is zero, hence:

$$y = 0 \quad \text{when } x = 0$$

Or,

$$C_2 = \frac{1}{24l} - \frac{1}{8l} = -\frac{1}{12l}$$

Thus the equation of the elastic line of the left half of the beam is

$$y = \frac{-64Pl^4}{\pi D^4 E}\left[\frac{-l}{5(1+2x)^2} + \frac{1}{2(l+2x)} + \frac{x}{6l^2} - \frac{1}{3l}\right]$$

Maximum deflection occurs when $x = \frac{l}{2}$, *hence,*

$$y_{max} = \frac{Pl^3}{24EI_{max}}$$

The deflection at any other point on the left half of the beam may be obtained by substituting the proper value for x in terms of l. As the beam and loading are symmetrical, the deflection of the right hand portion is also known.

A practical problem of this type arose in determining the deflection of several points on a vertical shaft for a gyratory crusher. The shaft had been designed for uniform strength; the load was considered concentrated at the maximum shaft diameter; and the ends were assumed as being point supported. For simplicity, the enlarged diameter at the journals was neglected, making the problem a general case of that as shown in Fig. 1 with a less than b and the diameter a function of $x^{1/3}$.

For a shaft of uniform strength $f = \frac{Mc}{I}$ at all points, hence:

$$d^3 = D^3\left(\frac{2x}{l}\right)$$

$$d^4 = D^4\left(\frac{2x}{l}\right)^{4/3}$$

Solution of this problem then proceeds in the manner as presented above except that the point of maximum deflection, where $\frac{dy}{dx} = 0$, occurs at an unknown location, making it impossible to evaluate C_1 immediately, therefore requiring it to be carried through the next integration. To determine the values of the constants we may set up a similar equation for that portion of the shaft where x is greater than a and get expressions for $\frac{dy}{dx}$ and y containing constants of integration C_3 and C_4. The deflection curve is continuous from support to support so that $\frac{dy}{dx}$ values from the two sets of equations are equal at $x = a$; that is, deflection, y, at $x = a$ is the same when calculated by either of the two corresponding equations. Also $y = 0$ for $x = 0$ for the section where x is less than a so that C_2 becomes zero. We then have three unknown quantities, C_1, C_3 and C_4. Equating values of y at $x = a$ we get C_1 in terms of C_3. Equating values of $\frac{dy}{dx}$ at $x = a$, putting $C_2 = 0$ and C_1 in terms of C_3 we can solve for C_4 from which we obtain values of C_1 and C_3. This finally gives an expression for the deflection of the beam where x is less than a, as follows:

$$y = \frac{96Pa(l-a)x}{5\pi ED^4 l}\left[2l + a - 3a^{1/3}x^{2/3}\right]$$

The amount of mathematical operation in the above is considerable and consequently solution by this method is limited in its applications.

For simpler calculations and to make possible the application of graphical methods, the bending moment diagram, called the elastic-weights method, is used. This is based upon the general principle that in a bent beam the deflection of a point from a tangent at some other point is

numerically equal to the moment of the $\frac{M}{EI}$ area between the two points. Mathematically:

$$y = \frac{1}{E}\int \frac{Mx}{I}\,dx$$

If, then, we take the bending moment diagram, divide the moment at each point by the moment of inertia of the shaft at that point, and use the resultant modified moment diagram as a loading diagram on a conjugate beam of the same length as the original shaft but of constant unit moment of inertia, the deflection at any point is the bending moment of the conjugate beam divided by the modulus of elasticity. The area of the modified bending moment diagram may be obtained by analytical or graphical integration.

For a simple illustration of this method consider the shaft in Fig. 2, with simple supports at the ends and the concentrated load as shown.

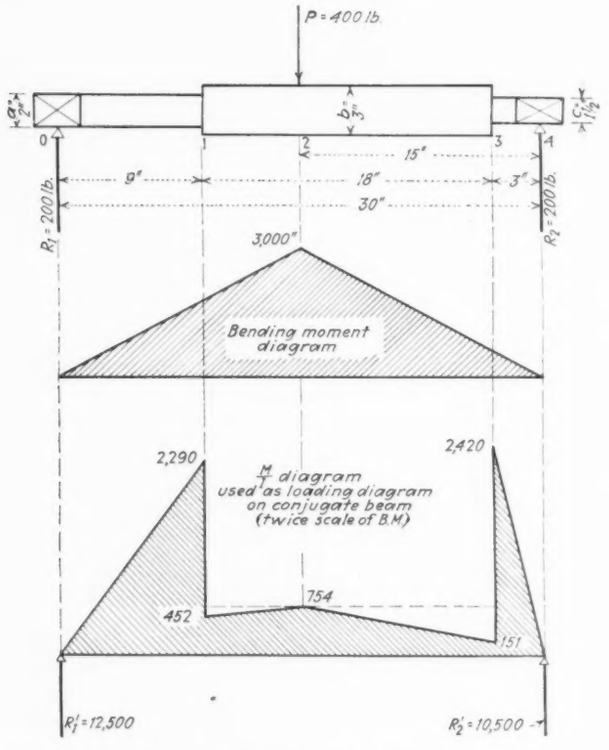


Fig. 2—Using graphical methods, the deflection at any point is the bending moment of the conjugate beam divided by modulus of elasticity

First, the bearing reactions and bending moments at critical points are obtained. In this example,

$$M_1 = 1{,}800, \quad M_2 = 3{,}000, \quad M_3 = 600.$$

Second, moments of inertia for the various sections of shaft are figured, resulting as follows:

$$I_a = 0.785, \quad I_b = 3.980, \quad I_c = 0.248.$$

Third, bending moments are divided by the moment of inertia of the shaft sections at that point.

$$\frac{M_1}{I_a} = \frac{1{,}800}{0.785} = 2{,}290$$

$$\frac{M_1}{I_b} = \frac{1{,}800}{3.98} = 452 \qquad \frac{M_3}{I_b} = \frac{600}{3.98} = 151$$

$$\frac{M_2}{I_b} = \frac{3{,}000}{3.98} = 754 \qquad \frac{M_3}{I_c} = \frac{600}{0.248} = 2{,}420$$

Fourth, the modified bending moment diagram is constructed with the above values and used as a loading diagram. The values of the reactions are found by dividing the area into rectangles and triangles and considering the whole area of each section to be concentrated at the center of gravity of that area section.

$$30\,R'_1 = \frac{2{,}290 \times 9}{2} \times 24 + 754 \times 18 \times 12 - \frac{(754 - 452)}{2} \times 6 \times 19 - \frac{(754 - 151)}{2} \times 12 \times 7 + \frac{2{,}420 \times 3}{2} \times 2$$

$$R'_1 = 12{,}500$$

$$R'_2 = 10{,}500$$

Fifth, calculate the moments of the conjugate beam.

$$M'_1 = 12{,}500 \times 9 - 2{,}290 \times \frac{9}{2} \times 3 = 81{,}600$$

$$M'_2 \times 12{,}500 \times 15 - 2{,}290 \times \frac{9}{2} \times 9 - 452 \times 6 \times 3 - 302 \times \frac{6}{2} \times 4 = 83{,}000$$

$$M'_3 = 10{,}500 \times 3 - 2{,}420 \times \frac{3}{2} \times 2 = 24{,}240$$

Sixth, divide the above moments by the modulus of elasticity to obtain the deflections.

$$y_1 = \frac{M'_1}{E} = \frac{81{,}600}{30{,}000{,}000} = 0.00272 \text{ in.}$$

$$y_2 = \frac{M'_2}{E} = \frac{83{,}000}{30{,}000{,}000} = 0.00277 \text{ in.}$$

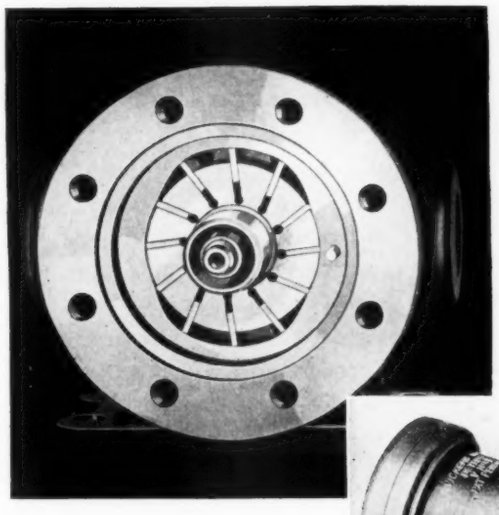
$$y_3 = \frac{M'_3}{E} = \frac{24{,}240}{30{,}000{,}000} = 0.00081 \text{ in.}$$

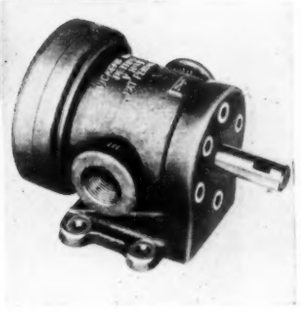
The deflection at any other points on the beam could be found in the same manner.

In general, if both M and I are expressed as simple algebraic functions of x the analytical solution by double integration may be employed; if either M or I, or both, vary irregularly the method of elastic weights should be used. The second method is always applicable but first may provide an easier solution in certain cases.

In the foregoing certain items have been neglected. The effect upon the deflection as may be caused by concentrated stresses at abrupt changes of cross-section, is negligible. Influence of keyways is neglected. Deflection from shear on beams of usual proportions, where the length is considerably greater than the diameter, is small enough to be neglected.

Constant-Displacement Pumps for Machine Actuation





THE ROTOR of the Vickers vane pump has twelve vanes and is capable of developing pressures of 500 to 1,000 lb. per sq.in.

Recent development of vane and centrifugal pumps has widened their application in the field of hydraulic control. Characteristics and performance data of these types are considered here

✦

ONE of the simplest forms of rotary pump used in hydraulic applications is the vane type, which in small compact sizes can be driven at fairly high speeds. Ordinarily, pumps of this class are fitted with a cylindrical slotted rotor that turns on an axis eccentric to that of the cylindrical bore of the pump body. In some cases the eccentricity of the rotor can be varied to change the volume pumped, as indicated in an earlier article, but only the constant-displacement type is considered here.

Vanes in pumps of this type usually oscillate radially in the rotor slots as the rotor turns, being urged outwardly against the case by springs and by centrifugal force, but in some pumps of this class the vanes reciprocate in slots in the casing, their inner edges being in sliding contact with the rotor surface. The vanes used vary in number from one to twelve. In pumps that have a single vane the latter is made so that it passes clear through the slotted rotor and is machined so that its edges fit closely to the cylindrical bore.

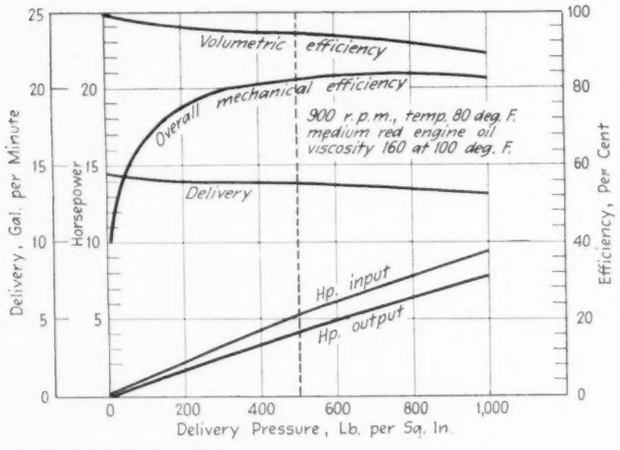
The greater the number of vanes the smaller are the pulsations in delivery pressure. Delivery, however, is continuous in all cases. Ordinarily, no valves are needed. Leakage or slip depends largely upon the fit of the vanes in their slots, against peripheral bearing surfaces and against end plates. Some pumps have automatic means for taking up wear and clearance.

One form of vane pump designed especially for hydraulic actuation of machines and capable of developing pressures of 500 to 1,000 lb. per sq.in. is the Vickers pump here illustrated. Its rotor is of hardened Nitralloy steel and carries twelve vanes of high-speed steel, which turn with the rotor and within a hardened ring of the same material as the rotor. The inner surface of this ring is not a true cylinder but has a harmonic curved surface at the ports. These surfaces join cylindrical surfaces near the largest diameter. With this arrangement the pressure difference at each side of each vane is said to be minimized and pulsations in flow to be virtually eliminated.

According to the data furnished by the manufacturer, the Vickers pump has a volumetric efficiency that drops only 10 per cent (from 99 to 89 per cent) as the delivery pressure is raised from 0 to 1,000 lb. per sq.in., indicating considerably less slip than for the gear type of pump. From about 300 to 1,000 lb. per sq.in. the mechanical efficiency also remains quite high, exceeding 80 per cent. Below 300 lb. the mechanical efficiency falls off quite rapidly, as the acompanying curve indicates.

A simple form of vane pump intended for use at pressures up to 200 lb. per sq.in. is the Romec,

which is made in sizes varying from $\frac{1}{4}$ gal. per min. at 1,750 r.p.m. up to 1,000 gal. per min. at 125 r.p.m. This pump has a single vane which passes through the hollow slotted rotor. The vane itself does not bear against the cylindrical case, but has between it and the case at each end a rocking shoe, which fits against a semi-cylindrical seat in the edge of the vane at one side and against the wall of the casing on the other side. Ports in this pump are arranged at 90 deg. apart and are quite large. Performance curves of the No. 02-H size having a $1\frac{7}{8}$ in. bore and running



PERFORMANCE curves of the Vickers vane-type pump. Only small changes in the high volumetric and mechanical efficiencies occur at high pressures

at 1,800 r.p.m. indicate that its volumetric efficiency decreases in somewhat more than a straight line ratio as the delivery pressure increases, being 99 per cent at 0 delivery pressure, 93 per cent at 100 lb. per sq.in. and 84 per cent at 200 lb. per sq.in. During this test a medium grade of lubricating oil was pumped at a rate varying from 6.8 to 5.8 gal. per min.

Applications of the vane pump are very similar to those of the gear pump, the two types often being used interchangeably. Where high volumetric efficiency is required certain types of vane pumps appear to be very suitable at high pressure. Decreased slip also tends toward increased economy in power consumption.

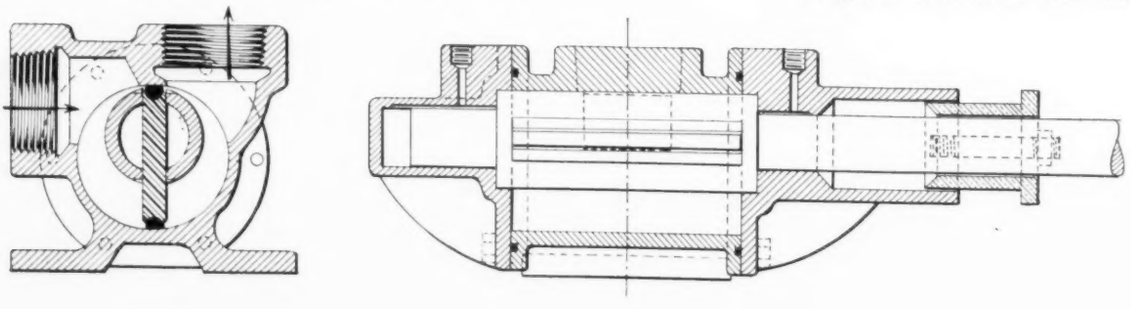
Although pumps of the centrifugal type have not ordinarily been considered suitable for hydaulic machine applications, partly, perhaps, because they are not positive in operation, they have been used successfully for this purpose. They possess, in fact, certain advantages, and in the single-stage type are made to develop pressures up to 250 lb. per sq.in. or more. In multiple-stage types pressures as high as 2,000 lb. can be developed.

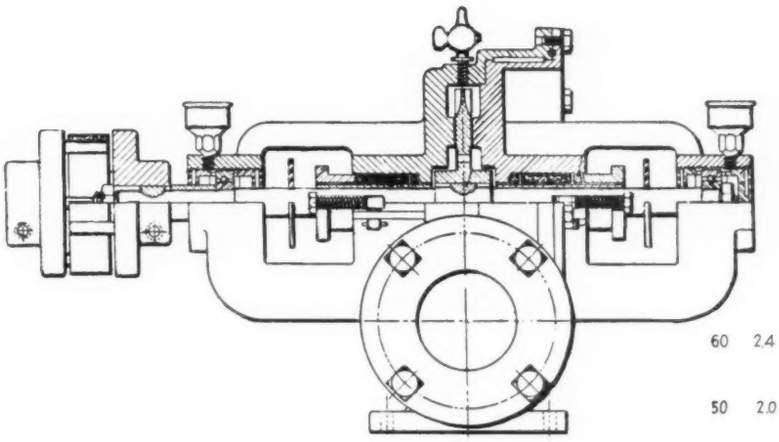
Single-stage centrifugal pumps have only one rotating element, and as a rule this impeller does not bear against any part of the case. Hence, it can wear only through erosion or corrosion. Although centrifugal pumps maintain a constant volume of discharge when driven at a constant speed, if pumping a constant head, a throttle valve at the outlet can be used to vary the discharge over a considerable range without serious loss in efficiency, and can be closed entirely without a material rise in pressure. Constant-volume positive pumps do not have this characteristic and should be provided with a safety valve or other protective device if any material throttling of the discharge line is introduced. Since centrifugal pumps run at high speeds, a direct-connected, high-speed motor can be used to drive them without interposing a reduction device.

Centrifugal pumps vary greatly in design of the impeller and casing. In some instances the impeller is hollow and is so arranged that the fluid pumped passes through it. In others a solid impeller with vanes on one or both surfaces is used. The number, shape, and arrangement of vanes also varies greatly in different designs. In designs such as the Worthington volute with hollow impeller, the vanes are curved to increase efficiency. The shape of the casing also has a bearing upon the efficiency of the pump. Efficiency varies too, and through a wide range with changes in discharge head, as accompanying performance curves indicate. The discharge curve is flat except for the extremities.

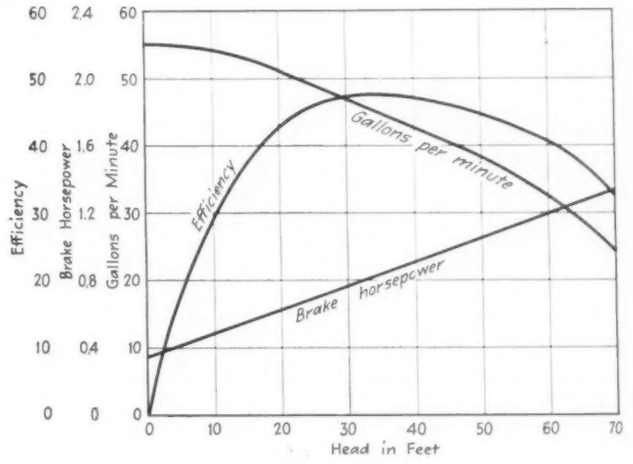
In addition, the volume of liquid delivered by a centrifugal pump decreases rapidly with increase in discharge head, although the power input increases in direct proportion to the increase

SECTIONAL views of the Romec vane pump. The single vane has D-shaped shoes interposed between it and the casing





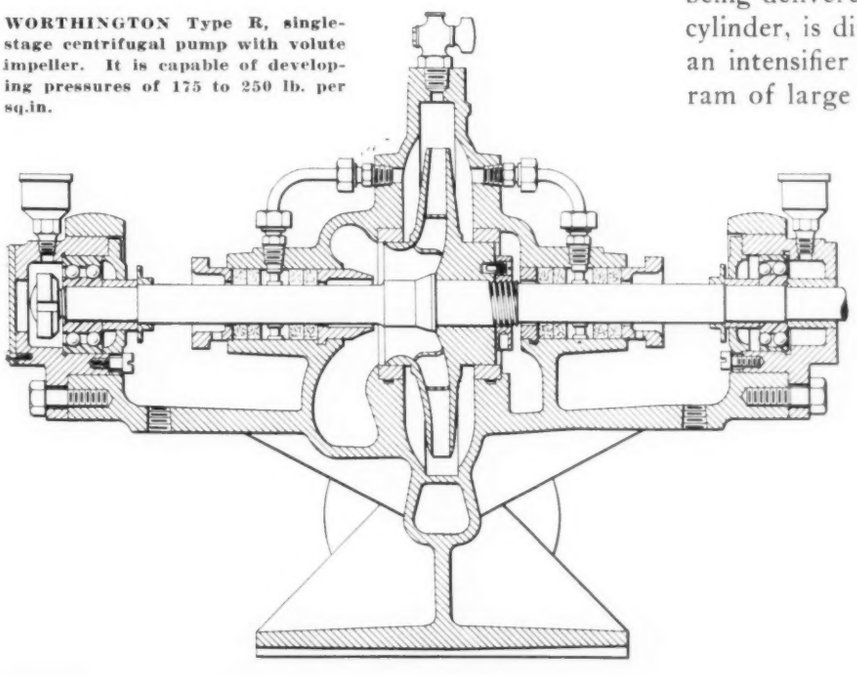
ANOTHER centrifugal pump, the Westco, having a single impeller with straight radial blades at each side, like others of this group may be coupled directly to a high-speed motor to give large deliveries over a wide range of pressures. The performance curve shows that the efficiency of this type varies greatly with the delivery pressure



in discharge head. For these and other reasons it is important in selecting a centrifugal pump to consider its performance curves and to select a type that will give maximum efficiency under the particular conditions of service to be imposed. In general the efficiency of a centrifugal pump is lower than that of well-made gear or vane pumps, but this disadvantage is sometimes offset by other factors such as reduced wear and lower upkeep.

For the actuation of shears and of other machines that require a relatively large volume of liquid at high pressure throughout most or all of their stroke, some form of high-pressure pump, often with an accumulator, usually is selected, but when hydraulic presses with a long stroke through only a part of which high pressure can be utilized are required, a system providing both high- and low-pressure liquid makes possible considerable savings in economy. In this case the low pressure brings the ram up to its work and later returns it, while the high pressure is available for doing the actual work. For such service a centrifugal pump in combination with an intensifier is well suited.

WORTHINGTON Type R, single-stage centrifugal pump with volute impeller. It is capable of developing pressures of 175 to 250 lb. per sq.in.



In a unit of this type, such as that made by the Baldwin-Southwark Corporation, the centrifugal pump is directly connected to a motor and is capable of delivering from 50 to 300 gal. of water per min. at 216 lb. per sq.in. This pressure is ample to open most presses and return the ram up to its work at quite high speed. When the ram reaches its work, the water, instead of being delivered direct from the pump to the ram cylinder, is diverted into the low-pressure side of an intensifier where this pressure, acting upon a ram of large diameter, actuates a second ram in a much smaller cylinder which in turn delivers to the press cylinder the smaller volume of high-pressure fluid needed to do the work for which the press is designed. At the end of the press stroke valves are again shifted and the low-pressure water is delivered to the press cylinder to actuate its ram on the return stroke and also to return the intensifier rams. Such a unit can be made fully automatic and is capable of completing from 5 to 25 strokes per min.

PRODUCT ENGINEERING

Editor: KENNETH H. CONDIT

October, 1931

. . . The real valuable trade secret is—have no secret. . . When a trade or art is in retrogression or is not progressive, then the secret may be kept. . . Stagnation of the individual and the trade is caused by trade secrets. . .

—JONES & LAMSON MACHINE COMPANY HANDBOOK

What Price Basis?

IT IS about a year ago that Henry Ford made the statement that the country would not see the end of the business depression until the lowest commodity prices in this generation had been reached. Apparently he was right. In fact, others knew at the time but were not in a position to speak their minds. Recently the lowest metal prices in this generation were touched, and one begins to speculate on how the new price levels of raw materials will affect the finished engineered product.

Theoretically there is an economic price level for each product below which the selling price cannot be cut without affecting the quality, where quality may mean the material, the mechanical functioning, the workmanship, or all three of these qualities. But where this point is located is not always easy to judge. For example, it is said that materials plus labor plus overhead equals the cost of the product. But when the cheapest available material has been adopted the designer may still alter his arrangement and use less material, or he may incorporate a material even more expensive which will overbalance its cost in less machining and finishing charges.

No feature of design should be overlooked at this time to bring down the cost of producing the product, but quality should not be sacrificed in order to place a product in an artificially created price level. If it is necessary to sell at a figure below the economic price, then one "grade" of the product should be developed for that price and a quality product created or maintained at a higher price. This is what the washing machine manufacturers have done and it is a sensible solution. No manufacturing plant can endure that sells below cost, and it is apparently up to the product development engineers to provide products that can be sold profitably at the current price levels.

■

Engineering on the Campus

WITH the expressed intention "to acquaint those active in engineering and manufacturing development with the latest progress in some particular field, in the hope that application of such knowledge will be stimulated," Case School of Applied Science will hold three "Industrial Conferences" during the academic year 1931-32, at which leaders in their respective fields will speak on technical subjects.

The expressed purpose is commendable. But of greater importance is the fact that Case students will be brought into intimate contact with industrial leaders and their problems. The ultimate gain will be great. Any undertaking that brings colleges and industry into closer contact should be supported for this, if for no other reason.

■

Speed

EACH year, when the National Air Races take place, we look at the newspapers to see what the new records for speed may be, and to see what the cost in human life has been. Most of us accept the new records without excitement and pay little attention to the effect which the achievements of the racers may have on everyday life.

But this year was different. In the first place there were no casualties, a most satisfactory outcome in view of the risks involved. And in the second place there was the astounding cross-country flight of Major James Doolittle.

After leading his field into Cleveland in the race from Los Angeles, Major Doolittle proceeded to New York to establish a new transcontinental record, returned to Cleveland the

same evening, and then went on to St. Louis as a passenger in another plane. In the morning he picked up some friends and flew back to Cleveland in time for them to see the events of the day.

What a thrill there is in such a flight, and how small it makes this country seem! But how pleased the engineers responsible for Major Doolittle's plane and engine must be at the success of their efforts in product engineering.

Not all product engineers can have the personal gratification of contributing to so spectacular an achievement, but there is just as solid satisfaction in seeing any mental conception take form and develop into a useful product. The product engineer may not look upon himself as an artist but there is open to him the same opportunity for self expression and an even greater chance to render useful service.

■

Finish Values

NOT ONCE, but many times, do we hear expressed in the engineering department the feeling that it is not worth while taking up the engineer's time thinking about finishes that constitute often only a fraction of one per cent of the total cost of a machine. And strange to say, obvious as is the error, it is hard to meet it with convincing logical arguments once it has become established in a designer's mind. Value of the effect of finish on a product has no relation to its comparative cost. One could just as well say that he will not comb his hair because it takes so little time anyway. But, perhaps the man with uncombed hair couldn't hold his job, and it is the same with a product.

There are innumerable items sold for fifty cents that are essentially the same as the ten cent article except that they have been given an attractive polish or a coat of lacquer. And it is well known that appearance goes a long way in selling an expensive automobile. In the case of industrial machinery the buyer may actually figure that appearance aids the productive capacity of the machine because of the effect on the workmen, or that the appearance is an asset in the enhancement of the value of his plant. It is just another application of the principle that "It's the little things in life that count."

New Ideas

IT may be a far cry from contract bridge to product engineering but there is nevertheless a lesson for product engineers to take unto themselves, and to pass on to their sales managers and presidents, in the recent five-day gathering of contract bridge teachers at the Roosevelt in New York. These teachers came to this meeting, spent five days and some hard cash to learn about a new "official" method of bidding.

Heretofore, each expert has taught his own system and stoutly defended it against all the other systems. Players who met casually at social gatherings or tournaments had to spend some minutes comparing their individual ground rules before they could go into action. Misunderstandings and more or less vitriolic conversation resulted. Then, along came an innovator who saw the idiocy of the existing tradition. By dint of considerable diplomacy and hard work he assembled the experts, showed them the selfish advantage to each of a standard system, compromised their differences, and the new "official" system was born.

It is a new idea and has carried its public by storm, and it is incidentally a splendid example of the standardization that engineers talk about, and occasionally adopt. Similarly, Walter Chrysler's bold experiment with the new Plymouth and its acceptance by the public has changed the feeling in automobile circles. Doubters who were convinced that the public would not buy any kind of automobile suddenly awoke to a realization that the market was just as ready as ever for something different.

A new idea in machine tool selling has filled a practically empty plant to three-shift capacity. Instead of peddling a single machine this company offers to install a complete production line, output guaranteed. It will supply other machines necessary outside of its own regular line, or it will recommend the ones needed to round out the unit. Its first order will keep it running overtime for months.

Here are three widely different examples of the success that is likely to reward a good new idea, carefully thought out and effectively merchandised. You can undoubtedly think of others. If your organization is not busy developing a new idea or product of its own, why isn't it?

✦ COMMENT ✦ AND SUGGESTION

THE COMMENT AND SUGGESTION SECTION is a forum for exchange of opinion. Readers are invited to write letters discussing matters of current interest to development engineers. Articles of a controversial nature, however, will be published only with a bona fide signature.

▼

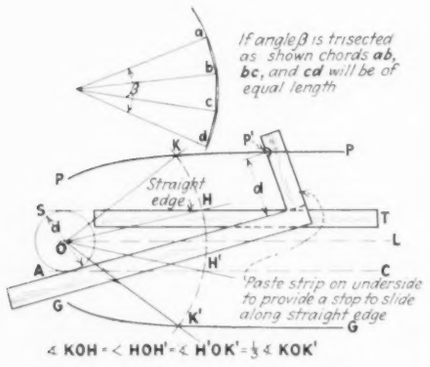
Trisecting Angles

By Fred T. Smith

EVERY now and then interest is shown by report from some mathematician or other that he has succeeded in trisecting the angle. To do this by Euclidian methods has long ago been proved impossible. However, the operation is quite simple if specially constructed curves are employed.

In the accompanying figure is shown a central angle subtended by the arc of a circle. If the central angle were trisected, each of the three fractional angles would have to subtend cords of equal lengths. The problem then is to find a construction that will divide any arc into three equal parts.

A trisection curve can be drawn readily by means of a disk, a square, and a straight-edge. These parts may


If angle β is trisected as shown chords ab, bc, and cd will be of equal length
Straight edge
Paste strip on underside to provide a stop to slide along straight edge
∢ KOH = ∢ HOH' = ∢ H'OK' = ⅓ ∢ KOK'

be cut from heavy cardboard, or if more permanency is desired, sheets of celluloid. The disk is made to any convenient diameter d and the perpendicular distance from the point P' to the inner edge of the square, as shown in the drawing, must be made equal to the diameter of the disk.

In operation, the disk is thumbtacked or otherwise fastened to the drawing paper, two horizontal lines ST and AC being drawn tangent to the disk as shown. The straight-edge is fastened to the board to coincide with the line ST. One edge of the square is then held against the disk while the inner corner is made to slide along the straight-edge. A pencil placed in the notch P' will then draw a curve PP as indicated. A similar symmetrical curve can be constructed by running the corner of the square along the line AC. However, this is not necessary.

The arc of any circle drawn with O as a center will then be trisected by the straight lines ST and AC and the curves PP and GG. This can be proved readily by plane geometry.

To trisect any angle, first bisect the angle and place the bisector to coincide with OL. Where the leg intersects the curve PP at K, draw an arc from the center O, cutting the horizontal line at H. The angle KOH will then be one-third the original angle.

Many variations of procedure are possible. Extremely acute angles may be accurately trisected by trisecting the angle equal to 90 deg. plus the given angle, and then deducting 30 deg. from the results.

■

STOP... LOOK... LISTEN...

•

. . . OPPORTUNITY MAKES NO NOISE . . .

DURING winter months the air in the average home has a humidity about on a par with that of the Sahara Desert, and it has been known that this condition has been a constant source for colds and diseases of the respiratory system. Air-conditioning to give the proper humidity for comfort and health, has been in operation for many years in factories and institutions. Within the last year one company has proceeded with the development of air-conditioning apparatus for the home. Now at least three more companies are preparing to market similar apparatus. Watch these products!

•

. . . PETRARCH WAS RIGHT . . .

EARNING power of the mechanical engineer is highest at the age of 55, according to an A.S.M.E. survey, and engineering salaries do not decline seriously with age. This is encouraging, and will tend to inspire the engineer with the realization that executives are convinced that experience and knowledge are of more value than ability to wave the arms and dance over a golf field.

•

. . . ALUMINUM TRUCK CHASSIS . . .

ALUMINUM alloys are constantly working their way into new uses. This time it is a truck chassis by the Fageol Company and saves 2,900 pounds on a 10-ton vehicle. There is nearly a thousand pounds saved in the unsprung weight. Of course it isn't a brand new idea in motor vehicles as the Pierce-Arrow Company built several automobiles with aluminum frames several years ago. It is only a question of balancing cost against advantages.

■

Too Many Oil Leaks

By Herbert Chase

ALTHOUGH great improvements have been made in the lubrication of the average machine now built, far too little has been done to stop unnecessary leakage of oil from bearings and other parts requiring lubrication. Such leakage is not only unsightly but results in great waste of lubricant and is not a credit to the designer who today has the choice of many means for sealing bearings against leakage.

Automobiles are among the worst offenders in wasting oil, as is proved by the coating of lubricating oil found on every highway today. When it is realized that the average price that motorists pay for lubricating oil is not far from a dollar a gallon, the total loss from leakage alone must aggregate many millions of dollars annually. It is well enough to advocate "twice a year" trips to the repairman but it would be more to the point and much more helpful to the

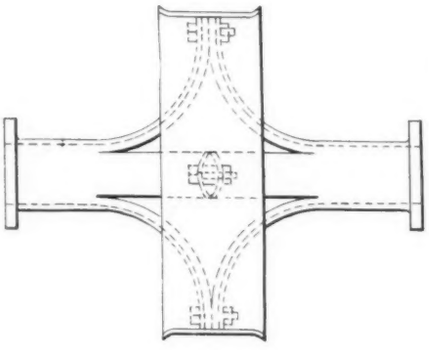
motorist if the automobile designer would pay more attention to applying means for preventing or minimizing leakage. I see no reason why leakage cannot be reduced to a small fraction of its present proportions if sufficient effort were applied in that direction.

■

An Ingenious Old Pulley

By Harry Shaw
Engineer, Heywood, England

WE pride ourselves upon our ingenuity in constructing machines from built-up structural steel, but a remarkable example of ingenious design is the pulley shown in the accompanying



illustration, which is probably a hundred years old. The pulley was made of two pieces of wrought iron pipe, each flanged at one end and split into four parts for a few feet up. The spilt sections on each pipe were then bent outward and bolted to a piece of flat wrought iron bent into a ring to form the pulley rim. The rim was fastened to the arms by allowing the bolts fastening the arms together to pass through holes in wedge-shaped pieces passing through the rim.

■

What Is the Answer?

By C. W. Hinman
Designer, Kobzy Tool Company

REFERRING to the article "Projection Method for Calculating Dimensions," appearing in the August number of *Product Engineering*, I recently had an occasion to solve a problem to which this method may be applied.

In the accompanying figure is shown a retaining bracket, a part of an electrical selective mechanism for making various changes in electric contacts. The relation of the 0.120-in. reamed hole to the position of the 0.615-in. radial slot must be exact.

. . . WORMS IN CARS . . .

WORM gears for power transmission date back to crude beginnings and have been in and out of favor with fair regularity. They have never gotten much of a toe hold in the automobile field, but there are indications of revived interest in worm-driven passenger cars, and new worm grinding machinery is said to overcome the defects of the past. At least two worm-driven automobiles are said to be preparing to make their bow at the next show and we may "learn about worm gears from them."

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. . . OR MAYBE AUTOGIROS . . .

A COMPRESSED air catapult has been built successfully in England for launching airplanes in places where no open field is available. Now, if someone designs a net for catching the planes, the big buildings in cities could be equipped as air passenger terminals.

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. . . WATCH THE PLASTICS . . .

A RADIO manufacturer in Europe is producing molded radio cabinets in cream color and light pastel shades. It looks as if the possibilities of molded materials have only been scratched. Low cost, light weight, color adaptability, and corrosion resistance are a few of the advantages in a material for innumerable product uses.

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. . . MECHANICAL WONDERS . . .

LIBERTY magazine carries a story in the issue of September 19 on "Rockets—the New Monsters of Doom." On the surface it looks like a wild sensational tale, but it isn't. The engineer who wrote it was an adviser to the British Government on Zeppelin aircraft during the War. The story is a glimpse into the marvels of what the product engineer can do to create a wonderful machine age. Rockets may yet carry mail across the ocean in a few minutes. If the new civilization abuses such mechanical inventions and makes them "monsters of doom," it is just too bad. The engineer is not to blame.

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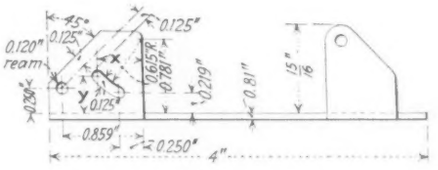
. . . STANDARDS . . .

SOME product engineers have the idea that standardization will turn them into robots who simply pick out certain mechanisms and put them together. If, however, one spends a little time in studying the automotive industry or telephone apparatus he will see that the designer still has quite a job left. In fact, he has more time to devise new ideas that are worth while, and after all there isn't much excitement or glory in deciding to use an odd-sized bolt or thread when the standards are just as good, easier to get and cheaper. Details are standardized, not products.

otherwise the mechanism will not function properly. Hence, the dimensions are specified in the manner shown.

However, it was necessary to find the dimensions "*x*" and "*y*" in order to dimension the position of the radial slot for the operator of the jig boring machine who had to make the parts



Can you calculate *x* and *y*?

for the necessary perforating and shaving punches and dies for this slot.

I found a very long and laborious method for solving this problem prior to the appearance of the above-mentioned article in *Product Engineering*. I then had the result checked by a professor of mathematics in a college, who computed the problem in an entirely different manner than either the method I had used, or the method published. The results checked with a variation of but 0.0005 in. I released my figures to the shop, and the tools are now made. Another set of calculations, made by another person, deviated from my figures by as much as 0.05 in.

It would be interesting to know what results would be obtained by the readers of *Product Engineering*. Incidentally, the figures should be correct to the fourth decimal point.

■

Halving Mixed Numbers

By C. Falik
Draftsman, Autopulse Corporation

HERE is a simple rule which I find useful in dividing by two a mixed number consisting of an odd number and a fraction. The odd number is divided by two, the whole number only being retained. The numerator and denominator of the fraction are then added to each other, the new denominator being taken as twice the old one.

An example will readily illustrate the simplicity of the process. Take, for instance, the number 5-27/32. One half of 5 is $2\frac{1}{2}$; only the two is retained. For the fractional part, 27 plus 32 is 59, thus obtaining 2-59/64 as being equal to 5-27/32 divided by 2. This process holds for any odd number and fraction.

WHAT'S GOING ON—

***Product Engineering*, together with other McGraw-Hill publications, will occupy this new building at 330 West Forty-second St., New York, N. Y., early in October. First industrial building in colors, this structure will house an auditorium and library for engineers and societies, a variety of other facilities and a modern technical publishing plant. Friends are urgently invited to visit and inspect these new facilities**

✦

National Metal Congress Discusses Materials

NUMBER, if not outstanding quality, marked the papers at the Thirteenth Annual Convention of the American Society for Steel Treating, held at Boston during the National Metal Congress and Exposition the week of Sept. 21. Most of the papers delivered and discussed at the sessions consisted of resumés or further detailed findings on already well-known subjects. Little in the nature of new developments was brought out.

Included in the group which held meetings during the Congress in addition to the A.S.S.T. were the American Welding Society, the Iron & Steel and Machine Shop Divisions of the A.S.M.E., the Iron & Steel and Institute of Metals Divisions of the A.I.M.E., and the Iron & Steel Division of the S.A.E. Standards Committee. Approximately 100 papers and committee reports were delivered at the daily sessions. The exposition of materials and heat-treating and other equipment was held at the Commonwealth Pier, with an increase of 50 per cent in exhibit space over that of last year.

Present trends in material research and usage, as might be deduced from the discussions at the Convention sessions, are: Wider acceptance by specifying engineers of the need for a specific alloy for each specific use, more detailed research into the action of corrosion, heat, and chemicals on the so-called corrosion-resistant metals, further advances in high-strength cast irons and alloy cast irons, increased knowledge of the detailed effects of working and treating on metals. Examples of the work being done along the two latter lines can be seen in the excellent paper on "Influence of Stress on Corrosion," by D. J. McAdam, Jr., of the Naval Engineering Experiment Station, and "Further Studies on Chrome-nickel-iron and Related Alloys" by Vsevolod N. Krivobok, professor of metallurgy, Carnegie Institute of Technology. Most of the papers and reports are available in printed form from the secretaries of the respective societies.

The Steel Founders Society of America, Inc., held its first fall meeting at the Sherman Hotel, Chicago, Ill., Sept. 16 and 17, opened by a joint meeting of the Special Sub-Committee on Recommendations to Designers, under the chairmanship of Ray S. Munson, and the Technical Research Committee, under the chairmanship of W. H. Stiemke. Reports of Cost and Technical Research Committees were presented the following morning, after which several sales sessions were held.

February 23-26, 1932, have been set as the dates for the annual Southwest Road Show & School at Wichita, Kan., which last year included exhibits from nine surrounding states and this year is expected to be larger. Exhibits of new road machinery, accessories, and materials are included. The program is largely on road construction.

Case School of Applied Science, Cleveland, and the Cleveland Engineering Society last year started a series of Educational Industrial Conferences, held at Case, with the intention of acquainting those active in engineering and manufacturing development with the latest progress in some particular field. In the spring of this year, three conferences were held, on Highways, Welding, and Electrical Control in Industry, including demonstrations of equipment. Considerable success attended these conferences. As a result the sponsors have now announced a new series of three conferences, Metals and Alloys, Air Conditioning, and Industrial Fuels. The conference on Metals and Alloys, scheduled for November 18-20, is arranged to appeal to three groups, including architects and structural engineers, power and process engineers, and design and product engineers. The use of alloys in the manufacture of machines, aircraft, and other products will be treated, including high-strength light alloys, bearing alloys, cutting alloys, hard alloys, etc. Demonstrations and exhibits of specimens and equipment will be conducted in the laboratories, including complete die-casting process with physical tests and X-ray examination, welding of special alloys, physical and metallurgical tests on and exhibits of various alloys. There is no charge for exhibition space.

News of the Metal Markets

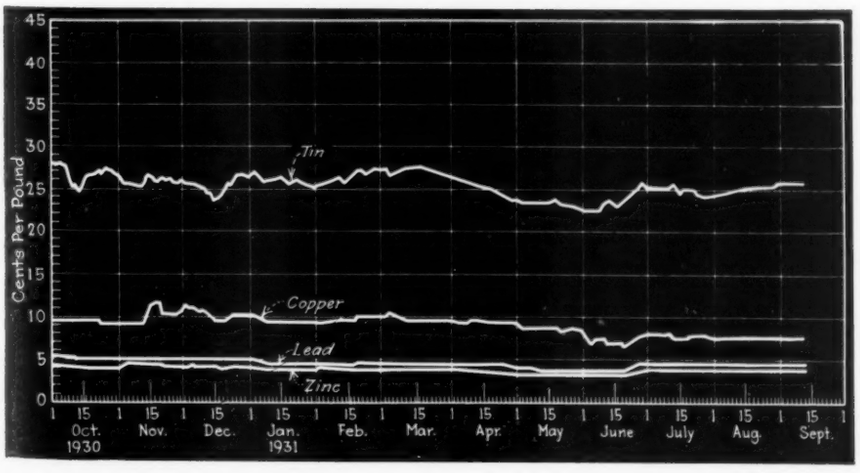
THE impossible has come about with copper prices fairly stationary below the low figure of 7.50c. In fact, acccording to *Metal and Mineral Markets,* seven and a half cent copper is available for purchase as far ahead as next March. Both domestic and foreign markets are dull, and as long as production exceeds consumption there is little chance that prices will advance. Some think they may drop even below the present low level.

LEAD demand has been relatively stronger than the demand for copper, and the price has been stable at 4.40c. But the market is such that even small quantities of reclaimed metal cannot be disposed of except at lower prices than the virgin metal. The London lead market has declined lately, but American producers do not see signs of any foreign lead coming into the market at the present time. Consumption of lead has apparently increased in the last few months.

ZINC has been firm at 3.80c. for more than a month. Although consumption appears to have dropped off, it is still ahead of production, which had been cut greatly. The brass manufacturers report a dull market, but there is evidently an increased consumption of the metal for die casting. Actual stocks of zinc are smaller.

TIN prices went up to above 27c. at the end of August with the news of a control agreement in the tin-producing countries, but dropped again to the level below 26c. because of the weakness in the London metal markets. Stocks of tin were considerable at the end of August.

MAGNESIUM prices have dropped to 30c. because of the increased efficiency of production. Announcement of the drop in price was made by the Dow Chemical Company, which company is obtaining the metal from brine wells in Michigan. Greatly increased consumption through new applications of this light-weight metal are expected. It is finding widened fields of use for automatic engine parts, reciprocating parts, and in aircraft.



Standards and Specifications

The three sponsor bodies for the Sectional Committee on the Standardization of Pipe Flanges and Fittings have submitted to the ASA for approval and designation as an American Standard, the May, 1931, draft of the Proposed Standard for Cast-Iron Pipe Flanges and Flanged Fittings for maximum non-shock working hydraulic pressure of 800 lb. per sq. in. (gage) at ordinary air temperatures. Manufacturers of welded chain who have accepted Simplified Practice Recommendation No. 100-29 have expressed their intention to identify the simplified lines in their new catalogs and trade lists. Signed acceptances have been received from a sufficient number of producers, suppliers, users and others interested in the simplification of packaging of overhead electric railway equipment to insure general adoption of the program by industry as a whole. Simplified Practice Recommendation No. R65-31 may therefore be considered effective forthwith.

Eighty representatives of 16 countries took part in the recent meetings of the International Federation of National Standardization Associations at Copenhagen, Denmark. Committees in attendance included those on aircraft matters, agricultural machinery, rivets, screw threads, drawings, ball bearings, and fit tolerances. Chief dimensions of both radial and thrust bearings have been agreed upon, and some progress has been made in developing agreement upon fit tolerances. Rivet standardization did not fare so well because of wide variation in opinion. It was agreed that the height of threaded nuts should be 0.8 times the thread diameter. International agreement is obtained for metric threads from 6 to 80 mm. and also for preferred metric fine threads. Probational use of German standards for thread tolerances was recommended to other countries. International standardization of drawings awaits further clarification and determination of a basis for agreement.

Meetings

American Gas Association—Annual convention and exposition, Municipal Auditorium, Atlantic City, N. J., Oct. 12-16. Kurwin R. Boyes, secretary, 420 Lexington Ave., New York, N. Y.

National Safety Council—Twentieth nanual Safety Congress (show in connection) Stevens Hotel, Chicago, Ill., Oct. 12-16. W. H. Cameron, secretary, 20 North Wacker Drive, Chicago, Ill.

American Gear Manufacturers' Association—Semi-annual meeting, William Penn Hotel, Pittsburgh, Pa., Oct. 15-17. T. W. Owen, secretary, 3608 Euclid Ave., Cleveland, Ohio.

Gray Iron Institute—Fourth annual convention, West Baden Springs Hotel, West Baden, Ind., Oct. 15-16. J. Arthur Tuscany, secretary, Terminal Tower, Cleveland, Ohio.

American Society of Mechanical Engineers—Sixth national meeting, Wood Industries Division, Robert E. Lee Hotel, Winston-Salem, N. C., Oct. 15-16. Calvin W. Rice, secretary, 29 West 39th St., New York, N. Y.

Southern Textile Exposition—Tenth annual, Textile Hall, Greenville, S. C., Oct. 17-22. William G. Sirrine, exposition manager, Greenville, S. C.

National Hardware Association of the United States—37th anual convention, Palmer House, Chicago, Ill., Oct. 19-22, in conjunction with convention of American Hardware Manufacturers' Association.

National Association of Farm Equipment Manufacturers—Annual meeting, Congress Hotel, Chicago, Ill., Oct. 21-23. H. J. Sameit, secretary, 608 South Dearborn St., Chicago.

Steel Founders' Society of America, Inc.—New York meeting, Oct. 22. Granville P. Rogers, managing director, 932 Graybar Bldg., New York, N. Y.

American Iron & Steel Institute—Annual meeting, Hotel Astor, New York, N. Y., Oct. 23. E. A. S. Clarke, secretary, 75 West St., New York, N. Y.

Dairy & Ice Cream Machinery & Supplies Association—Annual meeting and exposition, Atlantic City, N. J., Oct. 26-31. C. E. Breece, secretary, 225 West 34th St., New York, N. Y.

Home Lighting and Illumination Design—Two conferences, one Nov. 9-14 on home lighting, the second Nov. 16-21 on general illumination at General Electric Lighting Institute, Nela Park, Cleveland, Ohio.

American Society of Mechanical Engineers—Annual meeting, Engineering Societies Bldg., 29 West 39th St., New York, N. Y., Nov. 30-Dec. 5. Calvin W. Rice, secretary, above address.

Motor & Equipment Association—Annual convention and second joint trade show of M.E.A. and N.S.P.A., Atlantic City, N. J., Dec. 7-12.

IN THE SPOTLIGHT—

CHARLES P. MILLS, director of the Chrome Alloy Department, General Alloys Co., Boston, has resigned to become chief engineer of Empire Steel Castings, Inc., Reading, Pa. He was for many years chief engineer of the Duraloy Co., Pittsburgh.

J. B. ALLEN, formerly president of the Allen Engineering Co., Bridgeport, Conn., and prior to that with the Sperry Gyroscope Co., Brooklyn, N. Y., has been appointed special marine representative with headquarters at Harrison, N. J., of the Worthington Pump & Machinery Corp.

HARRY G. BALDWIN has become an engineer with the Norma-Hoffmann Bearings Corp., Stamford, Conn.

NILS G. BJORCK, formerly chief engineer of the Lange Motor Truck Co., Pittsburgh, has been appointed chief engineer of the National Motor Truck Manufacturers' Association, with headquarters in Chicago.

CLARE WESLEY BUNCH, formerly engineer and Wichita branch manager of the Pioneer Instrument Co., Brooklyn, N. Y., is now located at Linn Creek, Mo.

FRED C. BURKHARDT, chief engineer of the Crosby Co., Buffalo, has also been elected secretary.

ISAAC CHAR, formerly a layout draftsman in the special-equipment division of Chrysler Motors, Detroit, has become owner and engineer of the Automotive Engineering Service Shop, Los Angeles, building special bodies for commercial vehicles.

O. P. CLEAVER, Middle Western Division Engineer of the Westinghouse Lamp Co., sailed recently on the *Berengaria* for Southampton to attend the International Illumination Congress at London and Edinburgh. He also will extend his tour to include France and Germany, where he will make a study of European lighting design.

FRED H. COLVIN, editor of *American Machinist* and consulting editor of *Product Engineering*, has been appointed a member of the Special Committee of Introduction of Standards into Practice of the American Standards Association. The committee will consider ways and means of promoting company standards and of introducing standards into practice.

MAJOR T. G. LANPHIER, president of the Bird Aircraft Corporation, issued an open challenge to builders of the autogyro to compete with airplanes of conventional design, following the recent demonstrations at the Cleveland Air Races. Discussion at the races showed that airplane and autogyro makers are both taking advantage of new material and design development.

E. R. JACOBI, formerly executive engineer for the Kelsey-Hayes Wheel Corp., Detroit, has resigned to rest for a year in order to regain his health.

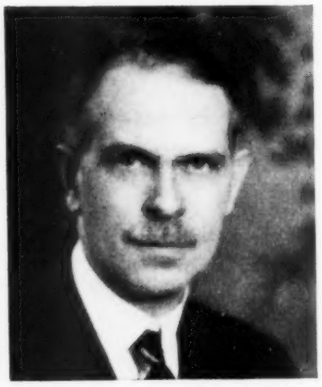
WILLI DIENENTHAL of Dango & Dienenthal, Siegen, Germany, associate of Edgard E. Brosius, Inc., Pittsburgh, designer and manufacturer of steel plant equipment, has been visiting for the past month in the United States.

A. R. DUFRESNE, chief engineer of the Canadian Dredge & Dock Co., Ltd., has been placed in charge of the office recently opened by the company in the Dominion Square Bldg., Montreal.

O. L. EGTVEDT, vice-president of the Boeing Airplane Co., Seattle, Wash., has assumed direct managership of the company, and G. W. CARR has been appointed plant manager. Mr. Egtvedt entered the service of Boeing in 1917 as design engineer, later holding the positions of chief engineer and secretary and was elected to the vice-presidency in 1926. As assistant to the president, Mr. Carr has acted in the capacity of plant manager for the past 2½ years. He entered the engineering department of the Boeing organization in 1924, became purchasing agent in 1926, and assistant to the president in 1928.

CHRIS J. FIELDS has become layout man for the Pierce-Arrow Motor Car Co., Buffalo.

PAUL GAY, for the past four years chief engineer of the Charlotte (Mich.) plant of the Sterling Mfg. Co., has been appointed Cleveland chief engineer.



C. P. Mills

T. G. Lanphier

CHARLES BAYLY FRANKLIN has resigned as chief engineer of the Indian Motorcycle Co., Springfield, Mass.

ALBERT G. GEISTERT, formerly with Adam Opel, A. G., Russelsheim a.M., Germany, as assistant chief engineer, is now consulting engineer in Detroit, with offices at 586 Goldengate Ave.

LEO G. HALL has been appointed to the staff of the Ryerson Physical Laboratory at the University of Chicago, in connection with experimental research in metals and alloys. Mr. Hall will continue his private consulting practice on problems and designs connected with high temperature, high pressure, and suitable electro-chemical technique and apparatus.

T. W. HALLERBERG, formerly assistant chief engineer of the Pickwick Motor Coach Works, Inglewood, Calif., has become body-layout draftsman with the Pierce-Arrow Motor Car Co., Buffalo, N. Y.

G. B. HAVEN, professor of machine design, Massachusetts Institute of Technology, has been appointed to represent the American Society for Testing Materials on the sectional committee on specifications for leather belting, which is functioning under the procedure of the American Standards Association with the American Society of Mechanical Engineers as sponsor.

R. P. LANSING, vice-president of the Bendix Research Corp., has been made president of the Lubrication Corp., Chicago, formed by the Bendix Aviation Corp., and the Standard Oil Co. of Indiana to manufacture and market grease fittings for automotive and industrial machinery. The company was incorporated in Delaware under equal ownership of its two sponsors.

GLENN MUFFLY of Copeland Products, Inc., has become a member of the staff of the National Electrical Manufacturers Association and will be located at the headquarters at 420 Lexington Ave., New York City. His particular function is to handle matters relating to the refrigeration safety code, on the standardization of which he has long been active. Mr. Muffly has been connected with Copeland Products since 1925 as chief engineer and consulting engineer. He retains the latter relation.

RALPH H. NESMITH, formerly connected with the United States Rubber Co., at one time plant engineer of the Providence (R. I.) factory, and in recent years in the engineering department of the Detroit factory, has opened an office at Room 605, Kerr Building, Detroit, Mich., for the engineering and sales of mechanical specialties.

OTTO NONNENBRUCH, for the past four years chief engineer of the Diesel Department, I. P. Morris & De La Vergne Inc., Philadelphia, Pa., and prior to that with the Worthington Pump & Machinery Corp., 2 Park Ave., New York, N. Y., in various capacities for nine years, rejoined the latter organization recently. He will make his headquarters at Buffalo, N. Y., as special sales representative there.

D. A. NEMSER, chief metallurgist, Pratt & Whitney Co., Hartford, Conn., spoke at a meeting of the New Haven chapter of the American Society for Steel Treating Sept. 17, at the Hammond Laboratory of Yale University, New Haven. His subject was "High-Speed Steel."

JOSÉ ROSAN, formerly engine designer with the Lycoming Mfg. Co., Williamsport, Pa., has joined the American Airplane & Engine Corp., Farmingdale, Long Island, N. Y.

WALTER D. ROBBINS, formerly vice-president in charge of engineering and manufacturing of the Gabriel Co., Cleveland, Ohio, has become vice-president and general manager of the Thermo Hydraulic Shock Absorber Co., Cambridge, Mass.

CHARLES E. SARGENT has been appointed consulting engineer of the National Transit, Pump & Machinery Co., Oil City, Pa. He was previously consulting engineer with the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

FRANK J. TONE, president of the Carborundum Co., Niagara Falls, N. Y., has been chosen as first winner of the Jacob F. Schoellkopf Gold Medal of the Western New York section, American Chemical Society, for achievements declared to constitute a major advance in science and to embody the spirit of research in industry. Outstanding contributions of Mr. Tone, as cited by the jury of awards, include his work with the late F. A. J. FITZGERALD on the properties and commercial applications of silicon carbide, the production of pure metallic silicon, and the industrial application of electro-chemistry.

EDMUND E. BURKE, for the past eight years on special engineering and sales work for the Kent-Owens Machine Co., Toledo, Ohio, has been made sales manager to handle both divisions of the company's operations. He will have charge of the projected development program. A special service department has also been inaugurated under the leadership of HAROLD STEVENS.

L. W. GREVE, president of the Champion Forge Co. and the Cleveland Pneumatic Tool Co., Cleveland, Ohio, and also president of the National Air Race Corporation, took an active part in arrangements for this year's races. He also presided at the A.S.M.E. program on "Engineer's Aviation Day" at which WILLIAM B. MAYO, chief engineer, Ford Motor Car Co., presented a paper on "Large Transport Airplanes."

WILLIAM H. WELCH, formerly research engineer of the Moto Meter Gauge & Equipment Corp., Toledo, Ohio, has become chief spark-plug engineer for the Firestone Tire & Rubber Co., Akron, Ohio.

CAMILLO WIEDEN has joined the Wright Aeronautical Corp., Paterson, N. J., as an engine checker.

ARTHUR L. WRIGHT, formerly physical metallurgist with the Linde Air Products Co., Buffalo, N. Y., has joined the Electrolux Co., Richmond, Va., in the sales and service branch.

CAPT. ENNIS C. WHITEHEAD, previously maintenance engineer on aircraft and engines in the Material Division of the Air Corps at Langley Field, Hampton, Va., has been appointed commanding officer of the 36th Pursuit Squadron at Selfridge Field, Mt. Clemens, Mich.

J. G. ZIMMERMAN, formerly research engineer of the Burgess Battery Co., Madison, Wis., is now engaged in research and development work on some inventions of his own and is also doing some consulting work in electrical lines.

Obituaries

DR. HARRY PHILLIPS DAVIS, 63, vice-president and director of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., and chairman of the National Broadcasting Co., one of the country's foremost engineers and executives, died at Pittsburgh, Sept. 10. He had been ill for several months following an operation. Nearly eighty patents were issued to him for his developments in electrical apparatus. Under his engineering leadership many of the most important advances of the electrical art were made, relating to meters, measuring instruments, circuit breakers, railway control apparatus, transmission equipment and radio. For more than 21 of the 40 years during which he was connected with Westinghouse, Dr. Davis was in charge of the engineering department, and for fifteen years directed engineering and manufacturing operations.

E. E. Burke

L. W. Greve

WILLIAM A. BARNARD, 86, until three years ago vice-president of the William Schallhorn Co., New Haven, Conn., and inventor of a number of mechanical tools, died Aug. 24.

RICHARD M. BEDELL, 67, who was connected with the Mergenthaler Linotype Co., Brooklyn, N. Y., for 39 years, latterly as head of the experimental department, died in Plainfield, N. J., Aug. 25, after a year's illness. He invented many of the improvements now incorporated in the linotype.

HOWARD L. BROWNING, 74, pioneer in the electrical field and inventor of a variety of devices used in electric lighting, died Aug. 11 at Pittsburgh.

HERBERT L. DEININGER, 54, for the past 18 years in charge of the experimental department, Cincinnati (Ohio) Ball Crank Co., died there Aug. 31.

BRUCE FORD, 59, inventor and engineer, who for years has been considered a leading authority in the storage battery field, died in Philadelphia, Aug. 10, after a brief illness. He was second vice-president and a director of the Electric Storage Battery Co., of which until recently he had been general manager. He had been connected with the company continuously since 1899.

DAVID F. GRAHAM, 69, retired mechanical engineer and for many years president of the Graham Roller Bearing Co., Coudersport, Pa., died Aug. 19 at a camp near Windsor, Canada.

JOHN D. NIES, dean of engineering at Lewis Institute, and vice-president of Kimble Electric Co., Chicago, Ill., died recently at St. Charles, Ill.

CHARLES PFAU, 73, owner of the Pfau Mfg. Co., Cincinnati, Ohio, and inventor of a number of plumbing and general appliances, died there Aug. 20.

JOHN A. REID, 73, vice-president of the Singer Sewing Machine Co. and Singer Mfg. Co., died at Rye, N. Y., Aug. 18. Mr. Reid's career with the Singer Sewing Machine Co. lasted 54 years during which he was instrumental in developing many of the power machines, some of them highly specialized, which are used in the garment industry. He retired in 1928.

CHARLES W. SPONSEL, 70, inventor of the Sponsel Rapid Fire Gun and a mechanical engineer of note, died Aug. 17, at Hartford, Conn. He was formerly for five years superintendent of the General Electric Co. and had many important inventions to his credit.

SIR THOMAS STANTON, 65, superintendent of the engineering department, National Physical Laboratory, and one of the foremost engineers of Great Britain, was found dead Aug. 31 at a Sussex beach where he had been spending a vacation.

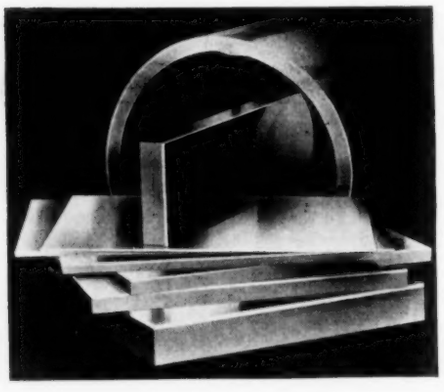
THOMAS MUIR THOMSON, 50, retired mechanical engineer of Port Joli, Quebec, died there Aug. 19.

SAMUEL T. WAGNER, 70, consulting engineer of the Reading Railroad, and vice-president of the American Society for Testing Materials, died at his home in Philadelphia, Aug. 7.

NEW MATERIALS AND PARTS AND ✦ ENGINEERING EQUIPMENT ✦

"Plykrome" Composite Steel with Stainless Surface

The cost of the so-called stainless steels has been a partial handicap in their application, particularly to the larger fabrications where heavy plates are required. For that reason, Industrial Welded Alloys, Inc., 225

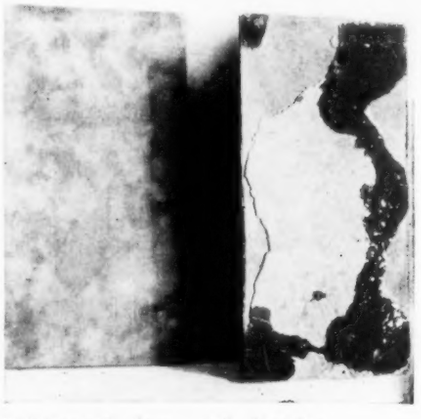


Broadway, New York City, began in 1927 to create stainless steel linings for tanks and other equipment, to effect maximum economy of the metal. An extensive period of research culminated in "Plykrome," a composite metal in which the stainless steel is veneered and completely weld-bonded to a mild steel slab.

Oxidation, the great detriment to welding, was prevented and the weld between the two plates has been constructed to permit expansion of the alloy under increased temperature without breaking its bond with the steel. The metal can be handled, bent, drawn, spun or flanged without cracking or parting the alloy from the steel. The ratio of alloy thickness to that of the sheet or plate can be anything desired, the plate having been made with 0.010 gage steel strip with an alloy ply of 0.00125 in. Present practice is to recommend a ratio of approximately 1:15 as offering greatest economy. In the case of heavy pressure vessels where 1-in. plate or a greater thickness may be required, the ratio may be 1:30.

Unlike plating, the thinnest alloy ply surface is claimed to afford complete protection. Test vessels have been subjected to boiling nitric acid for periods up to 150 hours with a conclusive demonstration that the alloy surface was completely homogeneous. The metal can be made with the stainless ply surface on one side, or both. The increased ultimate strength of the composite product is considerably greater than the proportionate thickness of alloy ply. One series of recent tests disclosed that, while the total thickness of the plate was increased 7 per cent by applying a veneer of alloy, the ultimate strength was increased 25 per cent.

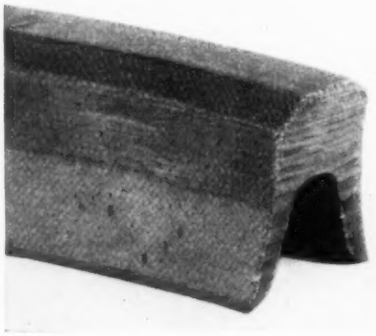
In the making of Plykrome a plate of the stainless alloy is welded to the steel slab, billet or bloom, before rolling. It is then rolled in accordance with usual mill practice into plates, bars, sheets, etc. The alloy surface is then sandblasted, pickled or polished depending on the use for which it is intended. The new composite metal has been and can be produced with its stainless alloy component of any analysis.



"Plykrome" face, and backing face repeatedly heated to 1,600 deg. F., and cooled. The ply face is unaffected

Diamond "U"-Type Hydraulic Packing

For service on hydraulic rams and presses, the Diamond Rubber Co., Akron, Ohio, is announcing "Rubber Crimps," or "U"-Type hydraulic packing, which is made in rings of standard sizes with a U-shaped cross-section. The rubber in this packing is especially compounded to resist oil, and is covered almost completely with a layer of fabric, which adds considerable strength and helps to maintain the $\frac{1}{4}$-in. flare at the bottom.



When the ram parts become worn, the flare tends to maintain a tight joint longer.

Among the features of this packing are: low cost; suitable for use at pressures up to 3,000 lb. per sq.in.; not affected by the heat generated in hydraulic presses; wears slowly and evenly; fits snugly, even when the ram is imperfect; thickness vertically through center is $\frac{3}{4}$ in.; will not dry up when a press is idle; and can be furnished in any standard diameter.

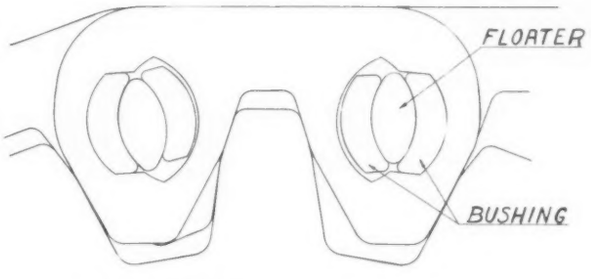
Morse "Pumpkin-Seed" Chain

For providing smooth power transmission by chain, or in other words constant angular velocity of the driven shaft, the Morse Chain Co., Ithaca, N. Y., has developed what is known as the "Pumpkin-Seed" chain, especially for grinding machines and other machines requiring high precision and no chatter marks on the work. Ordinary chain drives will not provide a constant angular velocity because the sprockets in effect are polygons and the chain a series of flats, thus causing a slightly pulsating pull and a rising and falling motion of the open strands of the chain. To obtain uniform angular velocity by means of a chain drive, it is necessary to provide a chain joint, which when flexing on a sprocket, has its center of articulation follow the sprocket polygon rather than the pitch circle. In the Pumpkin Seed chain this is accomplished by the lenticular center-pin and the bushings, by means of which it is possible to provide two centers of articulation. These centers are so located that the joint will articulate around one center, which moves along the sprocket polygon through the first half of flexing, and around the other center, which also moves along the sprocket polygon through the latter half of the flexing. The forward end of the approaching link is caused first to drop below the pitch circle and then rise to it, thus carrying the oncoming strand of chain without the rising and falling motion common in other chains. In this action compensation is obtained for the difference between the circular pitch and chordal distance by the curvature of the pin and a steady pull is thus maintained constantly.

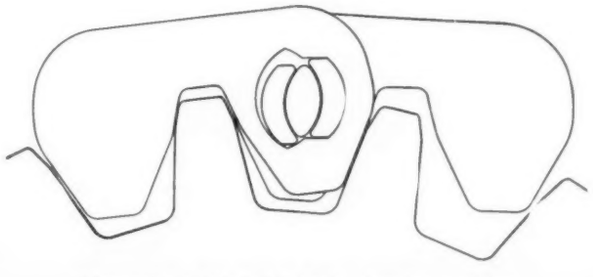
For absolute pitch compensation, a different pin would be required for each number of sprocket teeth. The amount of compensation necessary for correct action is, of course, more on sprockets having a small number of teeth than on those having many. A pin contour was therefore adopted which adequately compensates on the average number of teeth commonly used in small sprockets and which substantially does so within the limits of approved drive design. As the number of teeth increase, the polygon approaches the circle and the need of compensation diminishes.

Tests of this Pumpkin-Seed chain under standard conditions on a standard grinding wheelhead shows the performance of the chain consistently equalled the best obtainable by means of other transmissions.

Other features of the chain are quietness in operation, long life, flexibility, ease of installation, adaptability to center distance, no slip and capacity for overload. The chains at present are being used on precision grinding machines and milling machines.



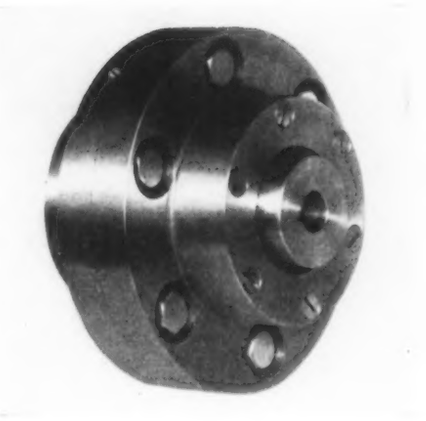
Morse Pumpkin-Seed Chain showing unflexed and fully flexed positions of pin, bushings and links at the start and end of flexing. The rotation is counter clockwise



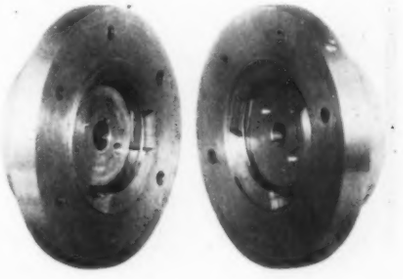
Morse Pumpkin-Seed Chain showing position of pin, bushings and links at point of half flexing. Rotation counter clockwise

Davis Flexible Coupling

A type of flexible coupling containing no springs, gears, bushings or perishable washers is being manufactured by the Penn Machine Co., Johnstown, Pa. The coupling embodies the principle of ball and socket motion. Hardened and ground socket keys sliding in keyways cut in the outer ring fit over balls imbedded in the hub and permit the coupling to compensate for misalignment.



The outer ring connects the two hubs, no matter what position they may be in, through the socket keys sliding endwise in the ring and rocking over the imbedded balls in the hubs. There is no change in the contact area whether the coupling is working under perfect conditions or extreme misalignment, since almost half the area of the balls is always in contact in the socket keys. All couplings are designed for extreme misalignment; the smallest sizes permit $\frac{1}{16}$ in. offset and 6 deg. angular misalignment, increasing with the coupling sizes up to $\frac{1}{4}$ in. offset misalignment. The number of imbedded balls and sliding socket keys is controlled by the size of the coupling. In the smaller sizes, three in each hub are provided, while larger sizes have a proportionally larger number. The couplings are made entirely of high-carbon forged steel with case-hardened and ground balls and socket keys. Couplings are available for every type of drive and load condi-



Hob, socket keys and outer ring in each Davis half coupling are held in position by a lock wire which fits in a groove in the outer ring. This wire keeps each half coupling intact while the coupling is being installed

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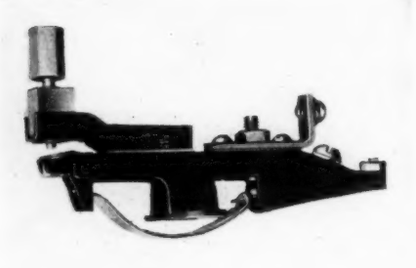
tion. Both shrouded and exposed type couplings are manufactured. Couplings to meet unusual operating conditions can be furnished.

A feature of the coupling construction, according to the manufacturer, is the ease with which it is installed. The hub, socket keys and outer ring in each half coupling are held in position by a lock wire which fits in a groove in the outer ring. This wire has no other function than to keep each half coupling intact as a unit while the coupling is being installed. Lubrication is performed through an oil filling plug on the outer ring. When the coupling is in operation all moving parts operate in a bath of oil, circulated to the points under load by centrifugal force.

Robbins & Myers 1,000-Watt A. C. Thermostatic Snap Switch

A positive snap action 1,000-watt capacity a.c. thermostatic switch for thermostatically controlled heating appliances is announced by Robbins & Myers, Inc., Springfield, Ohio.

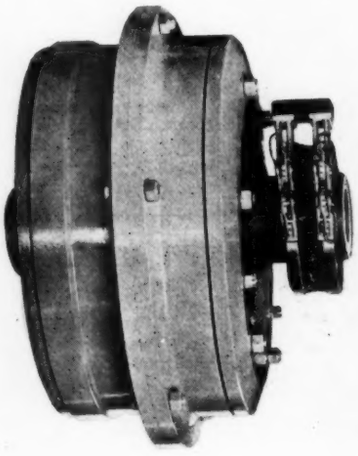


The switch maintains any desired temperature over a total heat range from atmospheric temperature to 525 deg. F. with a maximum variation of 5 deg. A special low-temperature type thermostatic snap switch to maintain temperature with a differential of but 2 deg. is also being placed on the market.

The switch stresses simplicity, compactness of construction and long life. It has but two moving parts, with resultantly greater durability and more dependable performance. It occupies from $\frac{1}{3}$ to $\frac{1}{2}$ less space than the ordinary snap switch, and the circuit-breaking spring is of a special steel. The switch is designed for easy application. It may be installed as part of the final assembly job, and can be made either to open or close with temperature increase.

"Stearns" Improved Multiple-Disk Magnetic Clutch

The Magnetic Mfg. Co., Milwaukee, Wis., has announced a multiple-disk magnetic clutch claimed to be extremely simple in construction, operation and adjustment. The clutch does not drive through spring plate or pins, the armature and field do not move relative to each other, and the entire clutch has no toggles, cams, rollers, or yokes to cause trouble. Only one wearing surface,

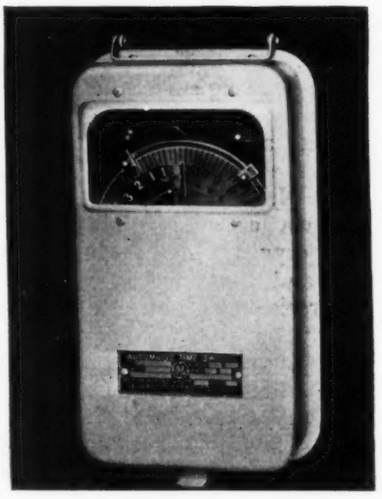


the friction lining, is incorporated, and this lining may be taken up for wear by a single adjustment.

Other advantages of the new clutch are: Reduced size, less space for installation; small diameter clutches take care of heavy loads; greater friction area; multiple disks provide ample friction area at low pressures, and reasonable cost. The accompanying illustration shows the assembled clutch with positive control elements.

General Electric Automatic Time Switch

For starting and stopping apparatus daily, or at various periods during the day, the General Electric Co., Schenectady, N. Y., has announced an automatic time switch designated as the Type T-13. This switch will perform such operations as starting motors in the morning, starting and stopping them throughout the day according to schedule and shutting them down at the end



of the day. It will care for industrial heating problems, since the apparatus may be turned on early in the morning so as to be ready for the workmen when they arrive. More complex operations can be done with the addition of special controls.

The Type T-13 switch is operated by a G.E. Telechron motor, as used in electric clocks, for timing the device, and features mercury-to-mercury "Kon-nec-tor" switches. It is designed for a.c. circuits of 115 volts and 30 amp., or 230 volts and 15 amp. It is available in single- or double-pole, both single- or double-throw types. The housing is such that the time switch can be used for either indoor or outdoor service. The case measures $10\frac{5}{16}$ in. in height, $5\frac{3}{8}$ in. in width, and 5 in. in depth. The instrument weighs $6\frac{1}{2}$ lb.

Jones 90-D and 105-D Herringbone-Maag Speed Reducers

A series of double-reduction herringbone-Maag speed reducers for small motor drives has been designed by the W. A. Jones Foundry & Machine Co., 4401 Roosevelt Road, Chicago, Ill. In design, construction and manufacture, these small machines are the same as the heavy-duty reducers of this company.

Double helical gears, generated right and left hand, in effect a herringbone gear with a wide gap, are used for the initial, or high-speed, reduction. The low-speed reduction consists of a Maag pinion and gear. Timken bearings are used throughout, assuring anti-friction mounting. The

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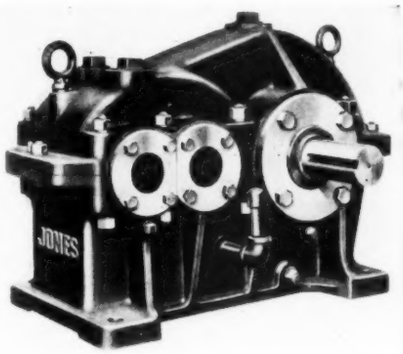
pinions are of heat-treated alloy steel and gears are of high-carbon forged steel.

All style No. 1 reducers are intended for torque drives through flexible couplings on both high and low speed shafts. The shaft diameters and bearing sizes are selected accordingly, since the majority of applications require coupled units. For overhung loads applied to the low-speed shaft, the machines are listed as style No. 4. For this service they are arranged with slightly larger gear

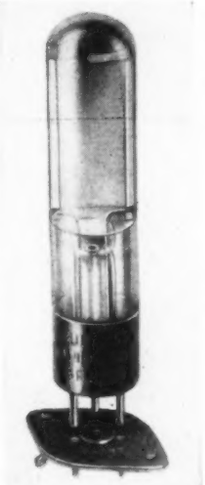


shafts and also with bearings of greater capacity than those furnished for the style No. 1 unit. Reducers in style No. 2 are furnished with the low-speed shaft extended and supported by a pedestal equipped with a roller bearing. These machines are intended for use with a sprocket or pinion assembled directly on the shaft between the reducer and outboard bearing.

An extensive list of ratios is carried in stock to insure prompt deliveries. Horsepower ratings vary from .9 to 2.8 for the 72-1 ratio unit, and from 5.2 to 8 for the 12-1 ratio unit, horsepower rating varying with the speed.

Burgess Radiovisor Bridge

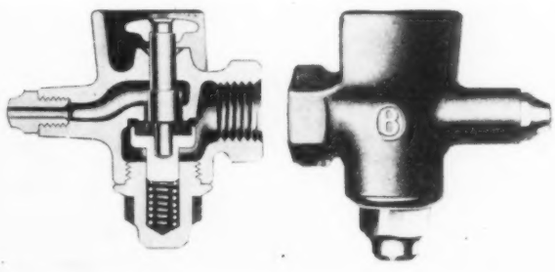
More than the usual current can be passed through the "Radiovisor Bridge," or photo-electric cell, announced by the Burgess Battery Co., 295 Madison Ave., New York, N. Y. In fact, the cell can operate a relay direct for controlling a circuit handling a few watts of energy. When a Burgess telephone relay of the type described in Vol. 2, page 379, is used, several hundred watts of energy can be employed. For more intricate applications, vacuum tubes can be used.



The bridges are available in d.c. and a.c. types. Each bridge has a rating of 0.1 watt per sq.in. of sensitive surface, the standard surface being 1.5 sq.in. The sensitized surface is located upon a plate of glass, upon the front side of which are two interlocking comb-like electrodes of gold, fused in place. These electrodes are covered with a thin layer of selenium-like enamel to provide the light-sensitive surface. A suitable optical system should be employed with this bridge so as to spread the light over the entire sensitive surface.

Ohio Blow Gun Valve

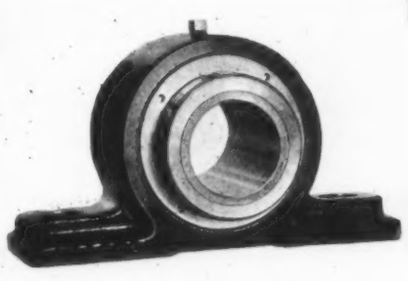
Experience in its own shops and foundries prompted the Ohio Brass Co., Mansfield, Ohio, to seek some design of blow gun which would conserve air and reduce maintenance expense and production delays. Such a blow gun is now being offered to the trade. Leakage, either through accidental opening or failure to shut tight, is avoided. A heavy flange of metal surrounds and protects the thumb button, insuring against damage from rough use and making opening impossible, except when desired by the operator. The disk is of a special soft composition and fits against a machined seat, where it is held in positive contact by a spring as well as by the pressure of the air itself. Much of the trouble and inconvenience of renewing disks is eliminated, since the stem of the valve will not slip out when the cap is removed. Ample air capacity is provided by the ducts and the size of the opening. The threaded end has an unusual amount of pipe clearance. The valve is regularly furnished with female threads in $\frac{1}{4}$- and $\frac{3}{8}$-in. sizes, but male threads may be had if desired.



Shafer Self-Aligning Roller Bearing Units

A line of self-aligning roller bearing units for normal-duty applications has recently been developed by the Shafer Bearing Corp., 6501 W. Grand Ave., Chicago, Ill. The company's double-row, self-aligning roller bearings, as used in standard-duty units, are now avaiable in these lighter weight, compact, simpler housings. The normal-duty units are furnished as pillow blocks, flange units, and take-up units, in a full range of shaft sizes from $\frac{3}{4}$ to 3 in.

The inner race of the bearing is extended on one end only and fastened to the shaft by a special locking collar. Sealing is accomplished by a grease seal consisting of two steel



stampings pressed into the housing or cover and having between them a $\frac{3}{32}$-in. fiber washer.

These stock units are self-aligning, without extra charge. Because of the concave-roller, convex-raceway assembly, the bearing carries the full load and rolls freely at the extremes of its self-aligning action. The bearing compensates automatically for minor inaccuracies in machining or deflection of the shaft.

The pillow blocks have two bolt holes for all units. The flange unit may be bolted at the side of a ma-

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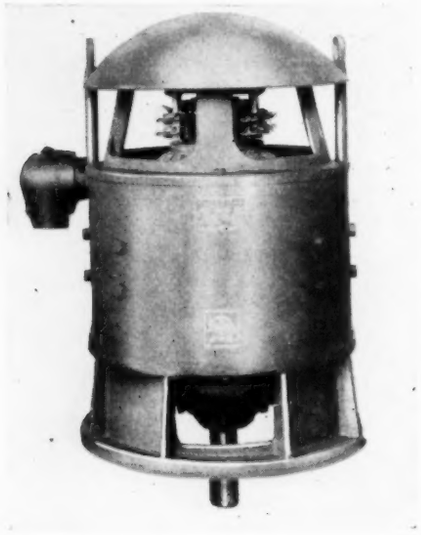
chine frame without machining. It can also be used as a step bearing for vertical shafts. Three bolts are used on the smaller sizes, and the larger units require four.

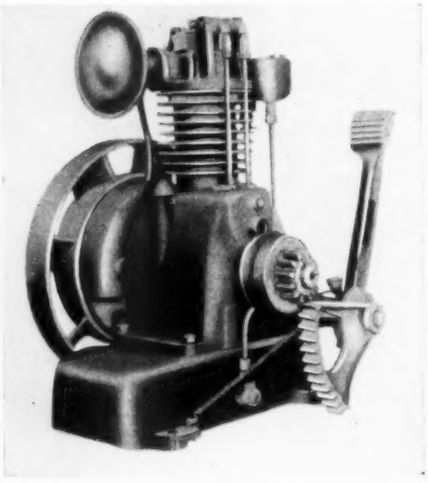
Reliance D.C. Vertical Motors

Type T, d.c. motors for vertical application in sizes up to 50-hp., 1,150 r.p.m., have been placed on the market by The Reliance Electric & Engineering Co., Cleveland, Ohio. These motors are provided with a ring base for mounting and a drip cover to protect them from falling dirt and chips and from dripping water, oil or other injurious solutions. Where it is desirable to do so, the motor can be mounted directly on the machine without the ring base, and will thus appear as an integral part of the machine. Large bearings are used to take up the thrust load, or weight, of the armature. Two heavy eyebolts are provided for easy handling of the motor. In other respects the construction is the same as the Type T, d.c., heavy-duty motor for horizontal operation.



"Jumbo" Fractional-Hp. Gas Engine

For incorporation in power-driven appliances requiring a gasoline engine, a "Jumbo" fractional-horsepower engine has been developed by Nelson Brothers Co., Saginaw, Mich. This engine is a single-cylinder, four-cycle, air-cooled type with speeds of



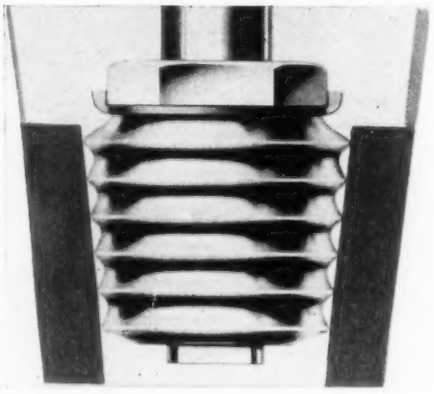
Jumbo Fractional-Hp. Engine for household and farm equipment

800 to 1,900 r.p.m., and develops $\frac{1}{2}$ to $\frac{3}{4}$ hp. The dimensions are only 16 in. high, $13\frac{3}{8}$ in. wide and $12\frac{1}{4}$ in. long. Typical uses are lawn mowers, washing machines, lighting plants, water supply plants, small compressors, sprayers and milking machines. Ignition is furnished by a high-tension Wico magneto inclosed in the flywheel, and an S.A.E. standard spark plug. Valves are of Silchrome alloy. A cast-iron piston with three rings is employed.

In this engine the crankshaft is drop-forged and is balanced with counterweights integral with the crank. The connecting rod is of bronze with bearings integral. Power take-off is made direct from the crankshaft with a V-belt pulley, or by sprocket, gear, or direct drive. Power can be taken from either side. Starting is accomplished by a pedal and ratchet. The fuel tank in the base has a capacity of $2\frac{1}{2}$ pints for a 5 hour run at full load. Weight of the engine is 60 lb. and the finish is enamel.

Ludlow Multi-Valve

Multi-stage reduction of pressure is the principle employed in the "Multi-Valve" developed in various forms by the Ludlow Valve Mfg. Co., Troy, N. Y. As shown above, the multi-stage stainless plug is corrugated with specially curved grooves on the sides, forming a number of contact lands that seat against the converging wall of the outlet. Instead of the usual drop from full to atmospheric pressure each contact opens into an expansion chamber in which the pressure is partially released, the density partially lowered, and the velocity lowered and further reduced. As a consequence, erosion is considerably reduced. The stainless steel cone swivels on the stainless steel stem. So long as its lands are in contact with the converging walls of the seat, the cone cannot revolve, but once free from the seat it rotates with the spindle. In this way the cone continually corrects any possible leakage by presenting a new sealing surface for contact with each successive seating.

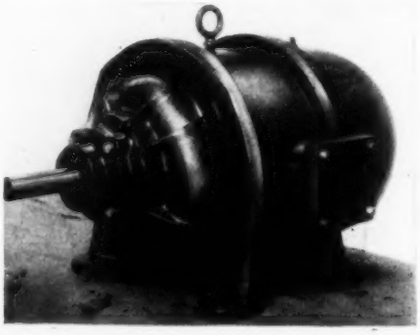


Multi-stage pressure reduction is effected by this valve plug

The beaded contact lands will cut through and crush scale and other solids without injury to the lands or the walls of the seat. As a consequence, the scale cannot find lodgment across the lands or on the seat. The valve will thus provide a tight closure at all pressures and temperatures for steam, air, gas, water, oil, viscous liquids and solutions.

Westinghouse Totally Inclosed Fan-Cooled Motor

For use in explosive atmospheres, a totally inclosed fan-cooled squirrel-cage motor has been developed by



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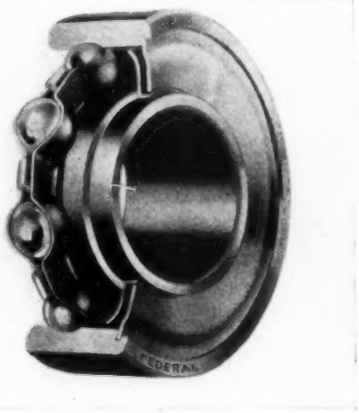
the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. This motor meets with the latest specifications of the National Board of Fire Underwriters for use in Class I, Group D, hazardous locations.

Free passage of cooling air is assured because of the large air passages and large spaces between the guard and the non-sparking aluminum alloy fan. The bearings are of cartridge type and have low maintenance and long life due to their location on the outside of the bearing bracket where the heat is dissipated in the cool air steam. The prewound primary core is interchangeable and renewable. The heavy conduit box is so designed that it may be turned in any direction to receive conduit. These motors operate efficiently either indoors or outdoors.

Federal Grease-Sealed Bearing

An all-metal grease-sealed bearing has been developed by the Federal Bearings Co., Inc., Poughkeepsie, N. Y. There is no frictional contact between rotating parts and therefore no rise in temperature or overheating at any speed. The efficiency of the seal is achieved by mechanical means.



The inner impeller and outer seal form a vacuum pocket, preventing suction of foreign matter into the bearing. The impeller continually throws grease into the races and onto the balls where it is required, and the vacuum retains the grease. The impeller is securely pressed on the inner bearing ring and the outer seal is spun into a recess in the outer race ring. Standard S.A.E. dimensions are always maintained and consequently no distortion in mounting is involved.

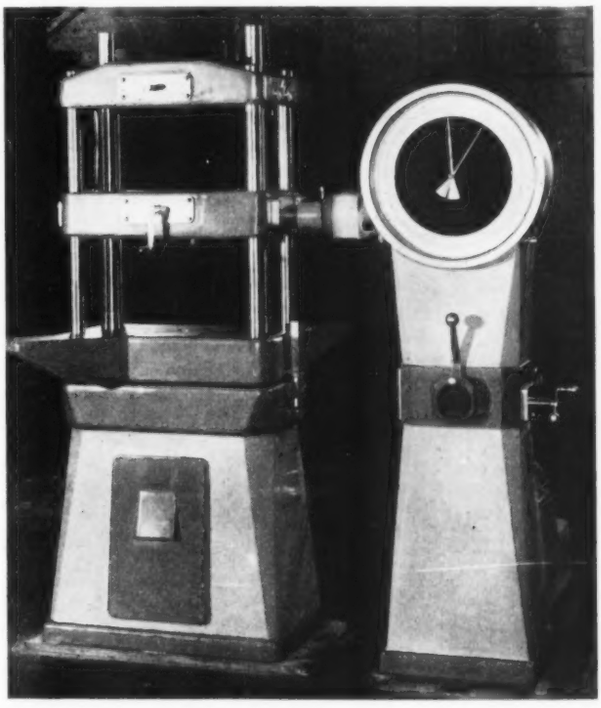
Riehle Precision Hydraulic Universal Testing Machine

Accuracy to within one-half of one per cent is guaranteed in the hydraulic universal testing machine announced by the Riehle Bros. Testing Machine Co., 1424 North Ninth St., Philadelphia, Pa. Among the features which make for convenience in use are: single lever control; self indication; dual load range on a single dial; instant load range transition; instant locking and self-releasing grips; convenient location of motor switches; wide space between screws; convenient storage space; head travel indicator; instant changing tools and grips; sensitive speed control; quiet operation; flexibility of set-up, and an open scale, easily read dial. The machine is manufactured in five sizes having capacities of 60,000, 120,000, 200,000, 300,000 and 400,000 lb.

The machine is built in three distinct units; the loading unit, the indicating unit and the power unit. The loading unit consists of the upper and lower heads in which are the grips for tension testing. The lower head is actuated by a motor and worm drive and the upper head and table by a hydraulic ram. The grips are of the familiar wedge type. But where the usual type grips must be moved up or down to seize the specimen, these grips move horizontally until they engage.

For the weighing unit, the pressure from the main cylinder is brought through a transfer valve so that it may be applied either on one plunger working singly or on two plungers working in opposition. When the single plunger is working, one-fifth of the hydraulic pressure capacity is sufficient to submerge the float to its full depth. When the two plungers are working in opposition it requires the full capacity pressure to submerge the float. This arrangement affords a simple and direct means of obtaining full-scale load indications either at full capacity or one-fifth capacity as desired.

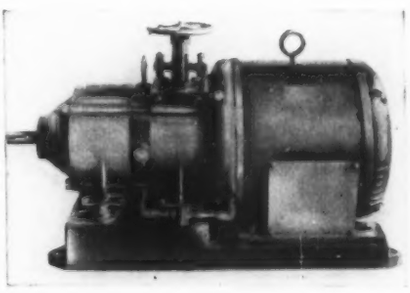
The power unit is a six-plunger, variable stroke, high-speed pump mounted in the oil tank and driven by a constant speed motor through a chain transmission. Delivery is regulated by a cam, operated by the control levers on the weighing unit.



Hele-Shaw 5-Hp. Electro-Hydraulic Transmission

A compact 5-hp. electro-hydraulic transmission has been announced by the American Engineering Co., Philadelphia, Pa. The transmission will develop full-rated torque at any speed, whether it be 1 r.p.m. or 1,000 r.p.m. Since the torque is constant the horsepower output varies with the speed of the hydraulic motor.

In the accompanying illustration the hydraulic motor is located at the left, the hydraulic pump in the



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center, and the electric motor at the right. These three units are mounted on a single bedplate reservoir, which contains the oil used in the system. The entire transmission, including motor, is 30 in. long, 14 in. wide and 16 in. high. The pump and motor are multi-cylindered and handle the fluid in a smooth, continuous stream.

The electric motor drives the pump shaft at a constant speed. Oil is delivered by the pump to the hydraulic motor at a rate corresponding to the stroke of the pump, which is regulated by the handwheel or any other desirable hand or automatic control. This is the only point of regulation, since there are no controls on the electric or hydraulic motors. Through the handwheel the speed of the hydraulic motor can be varied all the way from zero to maximum in either direction.

The pump end of the electric motor shaft is fitted with a fan. Oil in the system passes through a finned tubing surrounding the fan and consequently its temperature is maintained at a degree commensurate with efficient operation.

Welding Fittings Offer Advantages for Machine Piping

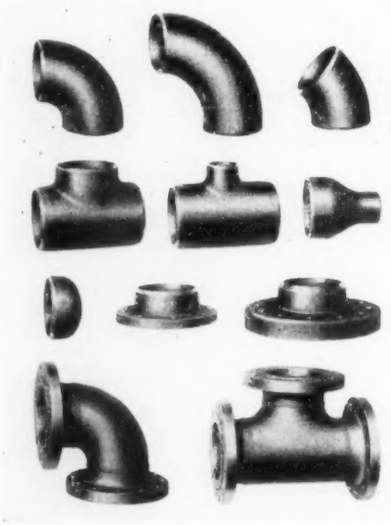
THE TREND toward welded construction in pipe lines has prompted three manufacturers recently to offer several types of welding fittings. These fittings offer reliability, neat appearance, ease of assembly, weight savings, and space savings when used as pipe joints in those classes of equipment requiring piping for hydraulic purposes, air, steam and other fluids. In general these fittings have been designed to be stronger than the pipe to which they are joined, and to have a flow area equal to that of the pipe so that the flow is not reduced or friction increased at the joints. By beveling the edges for V-joints the thickness of wall plus the bead is greater than the wall thickness of a threaded pipe, and the thickness of some of the fittings is increased over pipe thickness. Smooth sweeps are obtained to achieve neat appearance and smooth flow at high velocity, and ease of assembly is effected because the welds are circumferential and lining up is taken care of by simple jigs. Standard end-to-center-to-end dimensions are maintained. The weight of these fittings is less than for cast ones.

Taylor Steel Fittings for Welding

The Taylor Forge & Pipe Works, Chicago, Ill., has developed a complete line of seamless steel pipe fittings for welding, consisting of elbows, tees, reducing tees, bull plugs, reducing nipples, and butt-welding flanges. All sizes up to 24 in. inclusive will be manufactured, but sizes to 12 in. are now available. The tees are made in sizes from 2 to 8 in.

This line of seamless pipe fittings permits the entire pipe system to be fabricated by welding by the use of true circumferential welds, which are the easiest to make, result in best efficiency of the welder, and give full strength welds. The fittings are lighter in weight than cast-steel fittings, and require fewer and lighter supports. They require less space in erection than cast fittings.

The elbows are made without thinning or buckling of the walls, and have the advantageous feature of short tangents to facilitate welding and accurate lining up by simple jigs. Elbows are made of the standard center to end measurement of the American standard extra-heavy screwed fittings, and with end to center to end dimension equal to one and one-half times the nominal pipe diameter. The ends are machine tool beveled, providing a smooth, clean surface for welding.



Representative Taylor Forged Seamless Steel Fittings for welded pipe lines

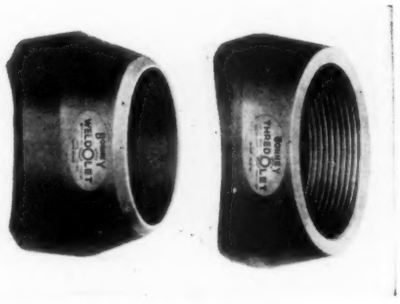
The forged tees are a tubular product made to pipe thickness at the ends, with the body thickened up especially around the outlet to give required reinforcement. The basis of design for the tee, as well as the other welding products, has been to make the fittings of an installation of welded fabricated pipe the strongest parts of the line. The tees have sweep outlets, a feature of importance for lines of high velocity.

The reducing nipples are designed especially for welding, with the length sufficiently long to aid installation, but shorter in dimension than that of the screwed reducing nipple. The butt-welding flanges, permitting insertion of valves in welded pipe installations, have a long fillet.

Bonney Weldolets and Thredolets

To meet the demand from the welding industry for a satisfactory method of making welded T-junctions, the Bonney Forge & Tool Works, Allentown, Pa., has introduced drop-forged "Weldolets" and "Thredolets." These units are individual fittings, designed to be installed by simply welding them to a pipe line, using a fusion or V-weld, then removing the button and completing the junction by welding or screwing the branch pipe to the Weldolet or Thredolet. Turbulence and friction are greatly reduced by the funnel-shaped outlet, which allows an unrestricted flow from the main pipe. Units are designed with a heavy external rib which provides great strength and in addition dissipates the excess heat when welding, thus preventing shrinkage and distortion. Two welds are required to install the Weldolets, one at the line of contact with the main pipe, the second where the branch and outlet of the Weldolet join. They may be used wherever it is necessary to make T's, side-outlet T's, crosses, double-crosses, etc., by

NEW MATERIALS AND PARTS

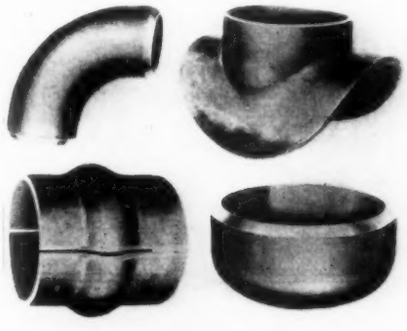


Bonney Weldolet and Thredolet

welding. Thredolets require only one weld, the outlets being tapped. It is only necessary to thread and screw the branch in position. They are suitable for low-pressure heating systems, for branch lines and radiator fittings. They may also be used to make any number of combinations of T's, double-crosses, side-outlet T's, etc. Weldolets are available to fit pipes from 1 to 12 in. Thredolets are available to fit pipes from 2 to 12 in. in diameter.

Midwest Welding Fittings

Welding fittings made from steel plate have been announced by the Midwest Piping & Supply Co., Inc., 145 So. Second St., St. Louis, Mo. These fittings are made to exact radius and sectional diameters, and are made perfectly round by means of a special compression sizing operation. On 90 and 45 deg. welding ell's there is one welded longitudinal seam along the inner circumference. These ell's have tangents to make it possible to quickly and accurately line up the pipe and fitting. The welds are more accessible and are removed from the point of maximum bending stress.



The line consists of welding heads, 90 and 45-deg. ell's, welding sleeves and welding saddles. The welding sleeve has a recess to permit its application over the conventional line weld, and thus the sleeve relieves the butt weld of any bending stress. Each half of the sleeve is slightly less than a semi-circle to assure a snug fit against the pipe. This sleeve reinforces the butt-welded joint.

Z-Metals Annealed White Cast Irons

High physical properties in white cast irons are obtained by a heat-treatment process and compositions developed by the Industrial Furnace Corp., Buffalo, N. Y. This company is licensing foundries to use the process for producing these so-called "Z-Metals." As distinguished from the annealed, or ordinary malleable, castings, these high-strength materials are characterized by the retention of some pearlitic structure, are less ductile and somewhat more difficult to machine. By application and extension of the principles of heat-treating, which had been successfully applied to produce fully annealed malleable cast iron, and by developing additional methods and compositions, it was discovered that white iron castings of increased tensile strength, and having other properties of value, could be produced in commercial quantities as in batches of 25 tons. These large batches are treated in an over-all annealing cycle of 72 hours, a comparative short cycle. With certain types of compositions, it has been found that selective properties may be attained, by varying the composition, temperature, and time of treatment.

The physical properties of the metals vary both with the composition and heat-treatment used. The possible varieties have been classified in four groups in accordance with their average physical properties, which are as follows:

GROUP I

Ultimate strength	100-110,000 lb. per sq.in.
Yield point	75- 85,000 lb. per sq.in.
Elongation	4-7% (in 2 in.)
Brinell hardness	240-260

GROUP II

Ultimate strength	90-105,000 lb. per sq.in.
Yield point	65-80,000 lb. per sq.in.
Elongation	7-10% (in 2 in.)
Brinell hardness	220-240

GROUP III

Ultimate strength	75-90,000 lb. per sq.in.
Yield point	50-65,000 lb. per sq.in.
Elongation	10-15% (in 2 in.)
Brinell hardness	220-220

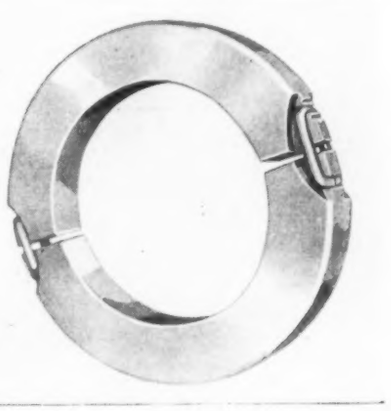
GROUP IV

Ultimate strength	70-85,000 lb. per sq.in.
Yield point	45-60,000 lb. per sq.in.
Elongation	15-20% (in 2 in.)
Brinell hardness	180-200

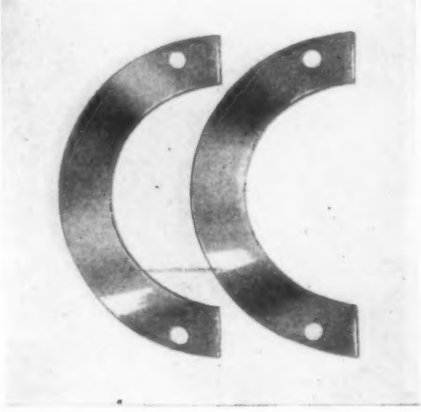
Wyeco Klip Nuts and Spacers

For making fastenings and spacing parts of an assembly, the Wyrick Engineering Co., Wyandotte, Mich., is offering Klip-Nuts and Klip-Spacers. These products differ only in that the latter can be shimmed to different thicknesses. Either device can be used directly as thrust or adjustment nuts, or they may be applied as spacing washers on milling machine arbors and in gear spacing. When they are used in lieu of a threaded nut, a groove in the shaft provides a seat for the device. The thrust strength is based on a direct shear action and is equivalent to a key drive the length of which is equal to the circumference of the shaft.

The camber usually present when bearing thrusts are taken on a threaded nut are eliminated by the use of these devices, thereby insuring that the entire contacting surface of both the inner and outer bearing races evenly divide the load. They consist of two semi-circular members hinged



Klip-Nuts and Spacers are identical, except that the latter are shimmed



Shims for Klip-Spacers, which are capable of considerable adjustment

NEW MATERIALS AND PARTS

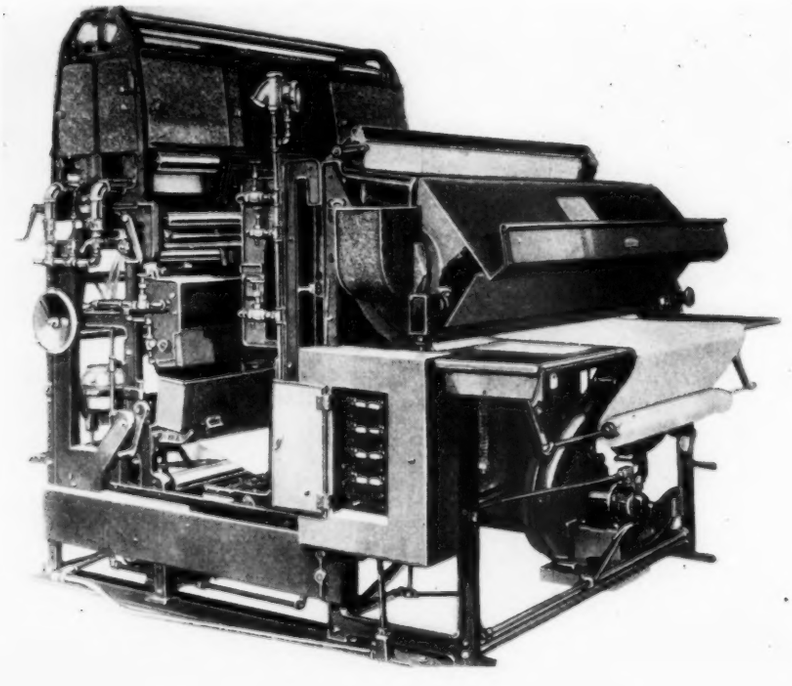
together at one end and a clip fastener provided at the opposite ends, thereby eliminating the necessity for sliding over the shaft. Whether the shaft rotates in either direction makes no difference as the device will not tighten or loosen by rotational action.

Internal diameters of these devices range from 0.503 to 6.004 in.; external diameters from $1\frac{1}{8}$ to $7\frac{1}{2}$ in. Adjustment of the Klip-Spacers ranges from $\frac{5}{16}$ to $\frac{7}{16}$ in. by shims for the smallest size to $\frac{9}{16}$ to $\frac{13}{16}$ in. for the largest size. Thicknesses of the Klip-Nuts range from $\frac{1}{4}$ to $\frac{1}{2}$ in. The devices are made in comparable bore sizes to the Wyromatick compensator described on page 40, Vol. 2.

"Peerless" Model "25" Blueprinting Equipment

A Pease "Peerless" Model "25" continuous blueprinting equipment, intermediately priced between the Pease Peerless Model "30" and the Model "20" blueprinting machines and combining many of the features of each, has been introduced by the C. F. Pease Co., 813-821 No. Franklin St., Chicago, Ill., is composed of only three units, the blueprinting machine, the washing machine, and the potashing, washing and drying machine. The blueprinting machine can be operated independently from the washing, potashing and drying equipment by means of a simple clutch adjustment. Also, it may be purchased separately and the other equipment added later when desired. All units are made in two sizes, 42 and 54 in. wide, and the machines can be wired to operate on 220 volts, either a.c. or d.c. The 42-in. machine is equipped with six lamps and the 54-in. machine with seven lamps. Each lamp consumes $6\frac{1}{2}$ amp. on d.c. and $7\frac{1}{2}$ amp. on a.c. but this amperage can be increased if faster printing is required.

This unit has a combination gear and sprocket chain drive arrangement, fully inclosed. The machine has a speed range of from 4 to 12 ft. per min., and is powered with a variable-speed $\frac{1}{4}$-hp. motor. Underneath the feed table at the right is a gear shift providing for two speeds: high, low, and neutral. Accurate printing regulation is obtained by a hand-operated dial at the front, connected by a sprocket chain to a rheostat underneath the feed table, thus providing instant change of printing speed to suit printing requirements. After exposure, when printing continuously, prints on the continuous roll of paper pass down into the first atomizer water wash consisting of spray jets which direct a pressure spray of water over the entire front and back surface of the paper. This removes all chemical and equalizes expansion or contraction of the paper. After washing, the prints pass over in contact with the chemical roll applicator in a shallow tray at the bottom center of the machine, revolving in the same direction as the paper is traveling and either potash or negative solution is uniformly applied over the surface of the prints. Both potash and hypo solutions are automatically fed into the tray from container at rear of machine and can be alternated in use as required for class of work being produced. After the developing process, prints are again washed in continuous operation as previously described by the second spray jet water wash arrangement. After this final cleansing they are carried over to the final operation of drying which can be done by gas or electric heat.



PUBLICATIONS

FOR THE ENGINEER'S LIBRARY

BALL BEARINGS. The New Departure Mfg. Co., Bristol, Conn., has issued its eighth edition of "New Departure Ball Bearings," covering dimensions, load data, and list prices. Important revisions and additions to previous listings of types, capacities, dimensions, and mounting details are made. This bulletin supersedes all previous editions.

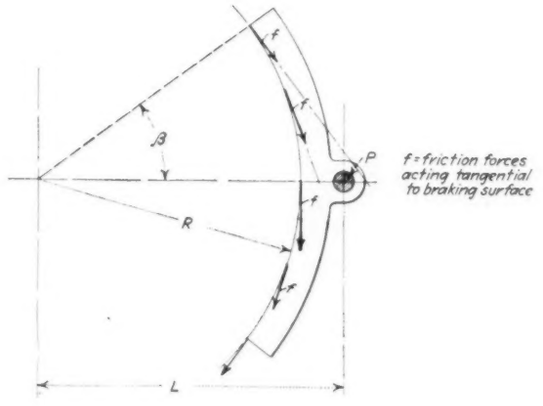
CAST STEEL. The Alloy Cast Steel Co., Marion, Ohio, has issued a booklet entitled "Cast AL Steel—Alloy and Carbon" presenting the characteristics of the steel castings which the company is prepared to furnish, and showing many typical parts.

HYDRAULIC TABLES. The Baldwin-Southwark Corp., Philadelphia, Pa., has issued Bulletin No. 25 entitled "Hydraulic Tables and Other Data." This booklet is for the engineer engaged in the design or use of mechanisms for producing loads by hydraulic means. Many of the tables have not been published previously. The booklet contains 31 $8\frac{1}{2}$x11-in. pages.

SHAPE CUTTING. The General Welding & Equipment Co., 70 Lansdowne St., Boston, Mass., has issued a booklet entitled "Machine Cutting—A Historical Lesson in Fundamental Economics." Its content cover the main fields of machine cutting and its importance for the industry; machine cutting; and automatic cutting machines. The booklet is very completely illustrated throughout with pictures of the machines and types of work which can be done.

SPEED REDUCERS. The Universal Gear Sales Corp., Indianapolis, Ind., has issued a bulletin on "Heliocentric" speed reducers, which gives complete information on the design, sizes and construction of these units which may have either clockwise or counter-clockwise rotation. The bulletin contains 75 $8\frac{1}{2}$x11 in. pages with tables.

Location of Brake Shoe Centers

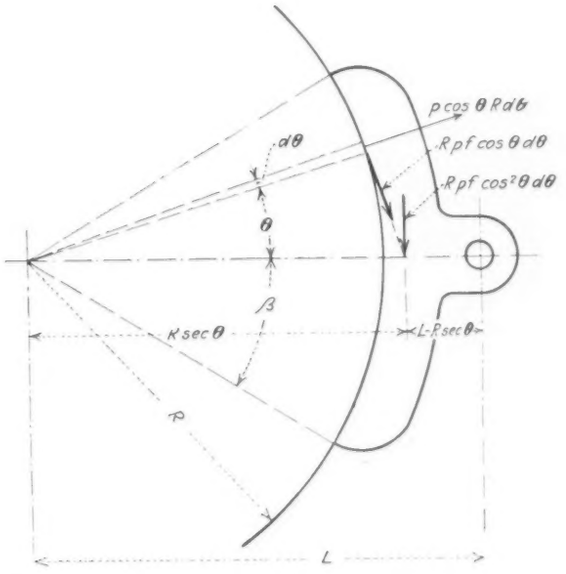


IN block type brakes, the location of the brake shoe pins has an important bearing on the distribution of wear. Referring to the accompanying diagram, it can readily be recognized that if the pin center P is too far from the face of the brake pulley, the tangential forces of the wheel on the face of the brake shoe will tend to cause the rotation of the shoe about the pin center P. Thus if the wheel be rotating in a clockwise direction, the pressures in the upper section of the shoe will be greatly increased, while the pressures in the lower section of the shoe will be greatly decreased. This will cause uneven wear. With rotation taking place in both directions, the results will be that the ends of the brake shoe will be worn considerably. Furthermore, the uneven distribution of pressure over the face of the brake will cause local heating and will considerably diminish the braking capacity. Uneven distribution of pressure of course means that there will be very high pressures localized at some portions of the braking surface, and the tendencies will be for the brake lining to wear more rapidly and the brake to chatter.

Referring to the accompanying figure the most desirable condition would be to have the brake shoe in perfect equilibrium about the pin P with respect to the friction forces. This would require that the point P be located at the center of equilibrium of the tangential forces as designated in the figure. Under such conditions, there would be no tendency for the brake shoe to rotate about the pin center P, regardless of the direction of rotation of the wheels or the magnitude of the pressure applied on the brake shoe. The maximum braking pressure would then always be at the center line and the most favorable distribution of pressure would be procured.

As in the case of the hemispherical seat of a pivot bearing, the wear distribution between the wheel surface and brake shoe will be proportional to the cosine of the angle θ, as designated in the figure. As pressure is substantially proportional to wear, it follows that the pressure will be distributed in a like manner. The pressure will thus be greatest along the center line passing through the pin. The frictional forces acting on the brake shoe surface will all be tangential to the circumference of the wheel at the point of application of pressure.

Referring to the figure, the brake shoe pin is



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located so that the shoe will be symmetrical about the centerline joining the pin and the brake drum center. In order that there may be no rocking tendency, the brake shoe pin must be located on a point along the centerline where the frictional forces will not exert a turning moment. As the construction is symmetrical, only the forces above the centerline need be considered.

Radial unit pressure equals $p \cos \theta$.

Force acting on a differential arc equals $p \cos \theta \; R \; d\theta$.

If f equals coefficient of friction, the tangential frictional force at any point is $Rpf \cos \theta \; d\theta$.

The component of this force vertical to the centerline will be $Rpf \cos^2\theta \; d\theta$.

Also the distance from the center of the drum to the point where the frictional force cuts the centerline is $R \sec \theta$.

If L be the distance from the brake drum center to the point about which the frictional forces are in equilibrium, we find that $L - R \sec \theta$, is the moment arm of the differential vertical forces, and the corresponding moment dM is

$$dM = Rfp \cos^2\theta \; d\theta \; (L - R \sec \theta)$$

or

$$M = \int_o^\beta Rfp \cos^2\theta \; d\theta \; (L - R \sec \theta)$$

In order that there be equilibrium, the summation of these moments must equal zero, whence,

$$\int_o^\beta Rfp \cos^2\theta \; d\theta \; (L - R \sec \theta) = 0$$

or

$$L \int_o^\beta \cos^2\theta \; d\theta = R \int_o^\beta \cos \theta \; d\theta$$

$$L \left[\frac{\theta}{2} + \frac{\sin 2\theta}{4} \right]_o^\beta = R \left[\sin \theta \right]_o^\beta$$

$$\frac{L}{R} = \frac{2 \sin \beta}{\beta + \frac{1}{2} \sin 2\beta}$$

Continuing the analysis, as above, the radial braking pressure on a differential arc is $pR \cos \theta \; d\theta$, and the horizontal component of this force is $pR \cos \theta \; d\theta \times \cos \theta$, or

$$dH = pR \cos^2\theta \; d\theta.$$

The horizontal components of the frictional forces need not be considered as they sum up equal to zero, those above the centerline being symmetrically equal and opposite to those below. Hence the summation of dH must equal P, the horizontal pressure applied to the brake, hence

$$P = \int_{-\beta}^{+\beta} pR \cos^2\theta \; d\theta$$

$$= pR \left[\frac{\theta}{2} + \frac{\sin 2\theta}{4} \right]_{-\beta}^{+\beta}$$

$$= pR \left(\beta + \frac{\sin 2\beta}{2} \right)$$

or

$$p = \frac{P}{R \left(\beta + \frac{\sin 2\beta}{2} \right)}$$

But the differential braking force, dF is

$$dF = f \, p \cos \theta \, R \, d\theta$$

or after integrating between the limits $-\beta$ to $+\beta$.

$$F = 2 R f p \sin \beta$$

Substituting the value for p as given in the above equation,

$$F = \frac{2RfP \sin \beta}{R \left(\beta + \frac{\sin 2\beta}{2} \right)}$$

or

$$F = \frac{2fP \sin \beta}{\beta + \frac{\sin 2\beta}{2}}$$

The braking moment will be

$$FR = \frac{2PfR \sin \beta}{\beta + \frac{\sin 2\beta}{2}}$$

Substituting, the value of $\frac{L}{R}$ given above,

$$FR = P f L$$

This fact is a self-evident truth that needs no mathematical demonstration, but is presented here to show how the relationships given above bear out one another. It also clearly shows the effect of the location of the brake pin on the amount of braking moment exerted.

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